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ROAD ISSUE

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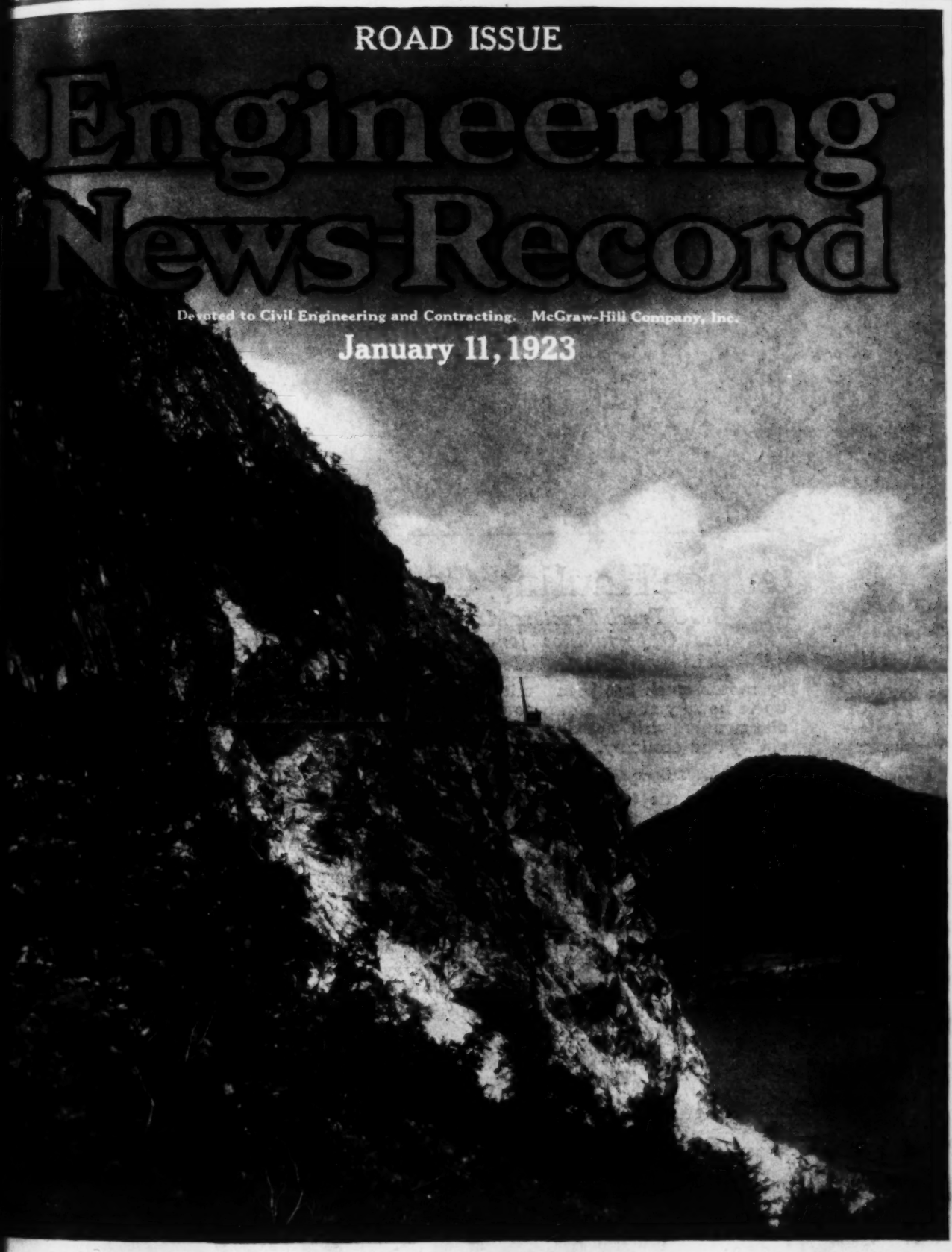

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Lessons From the Bates Road Tests — Is Highway Locating an Art? *A Symposium* — Economic Theory of Highway Grades, *by T. R. Agg* — Building the Storm King Road Along the Hudson — Research, Design and Construction of Highways; *An Editorial Review* — Twelve Columns of "Job and Office" Articles on Methods of Building and Designing Roads

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

E. J. MEHREN
Editor

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A Charge Not Proved

THE criminal indictment brought by the federal grand jury at Washington against the seven men associated with the Emergency Construction Committee of the Council of National Defense comprises 63 pages of closewritten typed manuscript. It is not a document lightly to be discussed or considered—for on its proof depends the reputation of men of hitherto unimpeached integrity, but pending a more complete analysis of the charges the following extract, which embodies the gist of the indictment, should be read by the construction industry:

> The defendants, each well knowing the stress under which the United States would be operating because of the sudden necessities arising on account of war conceived the fraudulent scheme and plan of getting control, for their own gain, profit and benefit, and for the gain, profit and benefit of their past and future clients, employers and their friends, of the administration of the immense emergency construction program of the United States during the war, including the determination of the policy to be followed, the form of contract grossly, unconscionably and fraudulently favorable to the contractors and in a like manner and to the same extent unfavorable to the United States, the selection of contractors, the letting of contracts thereunder and the supervision and administration of all emergency construction work of the United States during the war, and to that end did unlawfully and feloniously conspire, combine, confederate and agree together and with divers other persons to the said grand jurors unknown, to defraud the United States by unlawfully and corruptly delaying, impeding, obstructing, perverting, prejudicing, contravening and defeating the administration of its laws and lawful regulations.

Whatever technicalities of the law were violated in those early driving days of the war—and we have no doubt that the necessary cutting of red tape did involve some violations—we refuse to believe that the men back of the construction program were conspirators and traitors. The characters denounced in the intemperate language quoted are so different from those which the accused have been known to possess that every friend, not only of the men indicted but of the whole body of engineers and contractors who were a part of the war building program, will pray for the early trial of the case. A government department which will formulate such an attack and not hasten in every way to attempt to prove its justice is itself a travesty on justice.

The Engineer and the Small Detail

BUSY executives are often pictured as those men devoted only to broad problems of planning and direction. Small details are considered beneath their notice. Yet quite often the small detail, if wrongly handled, will wreck an entire program. Therefore does it happen that details often command executive attention. Particularly does it behoove the engineer and contractor to "cut the corners." *Engineering News-Record* has been publishing for a year a section wherein short cuts in field and office work have been described. More frequently than not contributions to this section have been from men who actually devised the thing described. For this special issue however, a request was sent to a number of executive engineers to supply the "From Job and Office" material. The material herein is an acknowledgement that no matter how busy engineers may be they have time in which to take intimate notice of the outstanding details of original work.

Still Room for More Light

THE consent decree handed down by Federal Judge Knox in dissolving the Gypsum Industries Association is of general interest chiefly as a judicial confirmation of some of the distinctions drawn nearly a year ago by the attorney general between the lawful and the unlawful activities of trade associations. It sheds no new light on the shadowy middle-ground that lies between what is generally accepted as being within the law and what is clearly under its ban. Among the most important of the border-line activities is the collection and compilation of statistics as to capacities, production, stocks and distribution and of the prices involved in completed sales. These were held by the attorney general to be within the law, but Judge Knox's decree falls short of a clear-cut confirmation of his ruling in these particulars. The distinctions that have been drawn are so generally accepted and the debatable ground has been so little narrowed by the decree that it is not easy to understand why it should have aroused so general a stir outside the gypsum industry itself.

Improved Road Building Equipment

ROAD-BUILDING equipment features this week's installment of *Engineering News-Record's* review of developments during 1922 in the construction equipment and materials field, begun last week. Roads of the higher type, as now built, while lacking in the spectacular features of a great bridge or skyscraper, are nevertheless large and complicated structures demanding, on the part of contractors, a great variety of heavy equipment. It has already been stated that the year just passed brought out nothing which could be classified as new in road-building plants, but scores of detailed improvements in standard types of equipment were made by manufacturers. Highway engineers and contractors realize fully that results now attained in road building have been made possible, in large part, by the manufacturers of construction equipment and materials. It is just as important to keep informed regarding improvements in machinery as to follow progress in design and the results of highway research.

International Road Congress

REPRESENTATION by the United States in the Permanent Association of International Road Congresses calls for immediate action by highway officials and the industries interested in highway development. The association is a technical body, composed of delegates from independent countries whose purpose it is to assemble and co-ordinate knowledge on highway engineering and highway transport. Leading all nations in highway construction, the United States certainly

should not lack a place in an organization from which it may gain much and to which it should be able to contribute abundantly. To participate, however, an act of Congress is required. The act does not involve an appropriation but merely an authorization to make the expenditure and take the action necessary to membership. The authorization is what the Department of Agriculture now asks for its Bureau of Public Roads. The request is approved by the State Department and by President Harding. Indeed all is accomplished except getting congressional action and this, at a "short session" crowded with bills of larger public concern, requires immediate effort. State and county road officials and everyone in the highway industry should write their congressmen and senators to pass the act of authorization. The action required is hardly more than mere formality, but it will not be taken unless it is urged emphatically.

The Lesson of Low Road Bids

LOW bids characterized highway contracting in 1922. This was particularly true of the early-season contracts. In Wisconsin, which is logically a low-cost state in road construction and where practically 90 per cent of the year's mileage was put under contract prior to May 15 there was a drop of about 30 per cent below 1921 bidding prices. In other states a similar if not an equal decline was exhibited by the bids submitted at the beginning of the year. As the season advanced and bad weather, poor railway service, higher prices and increased wages came along, bidding prices soared to a height not so far below those of 1921. Probably not all the low-price work was completed at a loss but it is certain that not much of it paid a reasonable profit.

Why did prices for road construction take such an extraordinary drop a year ago? We have the best explanation perhaps in a statement by H. J. Kuelling, highway construction engineer, that an influential reason for the low prices in Wisconsin was that "news of profits made in 1921 became noised about with the result that many new contracting firms sprang into being over night." The competition of these newcomers confident in their estimates predicated on the weather, wage, price and transportation conditions in 1921—one year in a decade in its conjunction of conditions favorable to construction operations—stampeded road contractors into a slaughter of prices which astounded the engineers who were taking the bids. Fear of being without a contract again demonstrated its power to fix the charge for doing work. Other influences contributed but they were largely fugitive.

The lesson is plain. In a stabilized industry the conditions indicated could not exist. Highway contracting is not stabilized. It lacks definitive knowledge of equipment performance, relative efficiency of methods and reasonable costs. It has not evaluated the influences that control progress. It has accumulated no general fund of quantitative information which indicates the boundaries of prices and profits. It has no established business policy. Its practices are individualistic and erratic. What happened early in 1922 is a natural consequence. It will happen again and again until contractors organize to stabilize their business policies and to determine the efficiency factors of their tasks.

The last year has seen progress in the organization of highway contractors. In only a few instances, however, have these organizations become awake to the fact that their greatest opportunity for power and influence lies in perfecting their own practices and not in wringing concessions from state highway engineers. The few who have taken the wiser course are getting returns in co-operation by highway departments and, incidentally, the concessions desired are being received as a matter of course. There is hardly a leading road-building state which does not now have its association of road contractors. The supreme task of each of these associations in 1923 should be to organize their skill and efficiency as road builders. It will be their greatest defense against irresponsible influences in their own business and their greatest power of attack against abuses in highway engineering practices.

Structural Progress in a New Phase

IN STRUCTURAL engineering the past year has developed something that gives promise of being most important: a new movement toward efficiency, based on thinking and motives different from those that controlled heretofore. A deliberate seeking for economy of material has developed, which is concerned with the elimination of useless safety allowances—the reduction of over-cautious margins of ignorance handed down as traditions from the early days.

It appears in many scattered items of activity, of which the better known ones may be called to mind. The demand for higher working stresses for structural steel, which has now given rise to a well directed engineering study of the subject; the advocacy and discussion of lighter brick-wall construction; restudy of frame-house specifications to promote economy by reducing unnecessary requirements, in conjunction with a progressive raising of timber stresses extending back over a number of years; the general movement to revise and, if possible, make uniform the building codes of various cities; the attempt to arrive at a more precise statement of fireproofing requirements, with the ultimate object of classifying fire hazards so as to permit each type of protective material to be used to its full scope, with due regard to light and cheap forms, such as fireproof lath and plaster construction; and the revision of reinforced-concrete specifications, now nearly completed. These separate enterprises and investigations, originating independently and at different times, are in fact all of them expressions of a broad general attitude of mind on the part of structural engineers that seeks to establish a new, higher-efficiency, basis of practice.

For a generation or two the art has developed by improving the calculation of stresses and making designs more rational. The results of steadily advancing engineering method, however, still had to be applied to practical service by way of basic standards (such as working stresses) that had come into existence by rather arbitrary judgment at an early period. The nature of these standards did not permit of their being changed from year to year, since they were built integrally into the whole structure of practice. Now, after years of concern with methods of calculation, details of design and processes of execution, engineers are turning back to scrutinize these standards as to their fitness.

To consider a specific case: wood construction, the oldest branch of the art, continued for long years on the basis of limiting stresses not far from one thousand pounds per square inch. Strength tests indicated

that these stresses would yield a factor of safety of about five; and, while no entire structure would probably ever have shown a ratio of more than two or three between working load and failure load, such conceptions as the "factor of five" held a commanding position, virtually until today. In recent years, however, several influences, most powerful of them the competition of other building materials, brought higher working stresses into use, as 1,400, 1,600, and finally 1,800 for the stronger woods, with no indication as yet that there is any lack of adequate safety so long as the detail design is good—and, in fact, no indication that working stresses have yet been raised as high as safety warrants. Large masses of test figures showing consistently high strength values give occasion for questioning the former low stresses, and invite study of how a safe and economical stress limit may be fixed.

Precisely this same development, leading to the same questions, is observable in the field of other materials. An advance to new standards may be looked for in each, and ultimately, no doubt, the traditional limits for all the widely used materials of construction will be subjected to searching inquiry. It is the general initiation of this movement of inquiry that marks the present time as the beginning of a new stage in structural progress, containing the possibility of far-reaching change in engineering practice.

Why—so runs the thought back of the new movement of inquiry—why should the engineer make great efforts in calculation and design to realize a possible saving of a few per cent, if twenty or thirty times as much material is consumed by a blanket allowance to cover the designer's mistrust in his own foresight and knowledge? How can so large an allowance be justified? A safe margin is needed, but not an unreasonable one; what this margin should be is the question to be answered.

Competitive pressure was the principal stimulus in raising questions of this kind, though not the only one. Wood becoming scarcer and dearer, found steel and concrete taking its place, and habit carried this substitution even beyond the cost balance, as is evident from the recent return to wood framing and roof-truss construction for many kinds of industrial buildings. Steel lost ground in the expansion of concrete construction, especially because concrete design was conducted on a fairly modern working-stress basis, while steel continued on the footing of a quarter century ago. The field of rolled steel was invaded by light pressed-steel construction. Brick similarly suffered through the competition of concrete, and in a measure also through the effect of bad industrial conditions of production and marketing. Competition between various fireproofing materials affected these as well as the system of construction to which they are practically adapted.

But in a sense the desire for modernizing traditional standards is the direct outgrowth of the wartime shortages in materials and the disturbed conditions of the reconstruction period. Emergency building for plant construction and housing during the war stamped insistent question marks on many accepted dogmas, and the topsy-turvy price relations of the years following the war emphasized them. The study of minimum dwelling-house design and other building code matters now going on under the direction of the Department of Commerce is an immediate consequence of reconstruction problems, as are also, though in a different way, the studies of timber design and brick-wall practices being conducted by commercial organizations of the industries. Incidentally, the fact that the building-code work has already extended to a radical restudy of house plumbing requirements—also suggested by reconstruction needs—gives an instructive illustration of how the movement for more economical use of material leads abroad into other investigations.

The relation of the new movement to past practice is perhaps best seen in the case of working stresses for steel in general building service. For many years all designing has been conducted on the basic standard of 16,000 pounds per square inch maximum stress in bending and tension, a figure whose origin is more or less lost in antiquity. Even the pressure of war demands did not weaken the sway of this standard much. But the war did teach that many things could be built of wood or concrete that had generally been built of steel, and in the restored free conditions of business after the war there soon arose strong demand by various commercial interests of the steel industry for an increase in working stresses, which would obviously give steel a new competitive advantage. Simultaneously, engineers also began to doubt whether the old figure was not unduly conservative. Discussion and agitation proceeded, until within the past year a technical committee to study the question was organized and began work.

Structural steel engineers, when they contemplate the 2½ to 3 ratio of ultimate strength to working strength used in concrete design, are naturally dissatisfied with the much larger ratio demanded in steel. But should they attempt to compare safety relations in structures of different materials and radically different character, they are confronted by a very complex problem. Further, they face the fact that, if the safety margin is to represent best economy of material, a degree of uniformity of material is required which, many protestations to the contrary, is not now satisfactorily assured. Still further, they are at a disadvantage in rational stress fixing because the much younger art of concrete construction can refer to tests of complete structures to verify its choice of stresses and its designing practice, while steel construction can not. And finally the use of steel involves fixed units of size and form in its rolled shapes, and it may be that the most efficient use of higher stresses would require a revision of these standards. Thus, a discussion of whether the old 16,000 figure should be changed leads of necessity to an intricate series of other questions, involving elaborate research, and bearing also on the correlation between engineering and its underlying industries. In the same way each single material that is made the subject of inquiry will bring about (if the inquiry is carried to its fullest extent) far-reaching study of engineering facts and principles, possible revision of industrial practice, and in any event much research.

We have spoken throughout of a new movement, a broad movement of general importance. That such a movement exists at the moment is certain; the fact is easily verified. Whether the movement really will prove to be broad and general more than temporarily, or whether it will survive for long, it would be mere speculation to predict. But if all members of the profession come to a full realization of the present situation, and appreciate the possibilities of the movement actively enough to give it their support and aid, they will place its successful progress beyond any doubt.

Progress Made in Highway Engineering

Administration a Pressing Problem—Research Leads All Activities—New Pavements Have Thickened Edges—Construction Exhibits Improved Efficiency

An Editorial Review

CONTRACTS for highway construction in 1922, measured either by the mileage of road or by the cost, exceeded those of 1921. Using the same measures, the volume of construction actually performed in 1922 was somewhat smaller. Reports available from about half of all states and including most of the states notably active in road building, promise a volume of construction in 1923 fully equal to that of 1922. The Federal aid system provided by law (7 per cent of the total road mileage of each state) aggregates 187,406 miles. At the rate of Federal aid construction in 1922, about 10,000 miles, this mileage will require from 15 to 20 years to complete.

There is, then, a reasonably sound basis for asserting that we may expect yearly, for a decade or more, a volume of highway construction perhaps not as great as that of any of the last three years but certainly of comparable magnitude.

The preceding statement demonstrates that highway construction in America is established as a continuing business of great magnitude. It is important that engineers and contractors should fix their attention on this fact. They have to prepare to administer a permanent construction business not merely to carry out a big construction job. All collateral industries—equipment manufacturers, materials producers, purveyors of transportation—have to organize for a continuing market. The problem and the opportunity are similar, with essential differences, to those of our period of intensive railway construction. They have to be approached and grasped with the certainty of clear engineering knowledge and business intelligence which distinguish the best examples of railway administration.

Growing consciousness of highway development as a permanent institution ranks high among the accomplishments of the year. It brings problems of highway administration to the front, where their place is, just as in railway direction principles of administration take precedence of research, design, construction or maintenance.

Research Activities — Research outstripped every other highway engineering activity in 1922. More progress was made investigating road design and structure and determining the traffic demands on modern roads than during all previous time. This does not indicate that design, construction and maintenance have lagged, but that research has accelerated its advance.

By a careful census undertaken by the Advisory Board on Highway Research of the National Research Council, it was disclosed that there were in progress in the United States, as of December, 1922, 486 research projects in highway engineering and highway transport. Naturally most (267 of 486) of these projects are investigations of materials, but there were listed 58 studies on economics, 18 on operation, 119 on road design, 7 on vehicle design and 17 on construction.

Possibly traffic tests deserve to lead in any consideration of highway research in 1922. At all events their spectacular nature has made them better known than other investigations. Leading these traffic, or service tests, of course, is the Bates Road test in Illinois, the essential results of which are published on p. 57 of this issue. Second in magnitude to the Illinois tests come those on the Pittsburg Road in California which were outlined in our issues of June 29, 1922, p. 1066, and Nov. 23, 1922, p. 893. Supplementing these service tests, with standard trucks and full-size road sections, are the tests at Arlington, Va., by the Bureau of Public Roads where loading machines are traveling on circular tracks to determine wear and other surface action of traffic.

With the new series of truck impact tests of the Bureau of Public Roads, the three investigations mentioned are notable achievements in which technical knowledge and highly advanced technique are combined. Outstanding as practical results are the conclusions that if existing paved roads are to endure there must be strict load regulation and that balanced strength calls for a pavement having edges thicker than the center. Here then is a lesson from research that possesses the utmost practical economic value.

As great practical value is contained in the supplementary fatigue tests of concrete which have been under way at the University of Maryland, at Purdue University and at the laboratory of the Illinois Division of Highways. These tests have gone so far as to make reasonably certain the conclusion that concrete pavements will endure indefinitely under repeated loads not exceeding half the modulus of rupture of the concrete. With greater loads the pavement fails by fatigue. With this knowledge and knowledge of the strength of the concrete, safe truck loads can be determined with some accuracy. It is even predicted that, using the new strain gage designed by the Bureau of Public Roads, it will be possible to determine the bearing capacity of old pavements of unknown original strength so that load limits may be named.

While pavement investigations have been most emphasized in the year's research, unpaved roads and particularly gravel roads have been intensively studied The studies on dust preventives by the Michigan State Highway Department and on rhythmic corrugation by the Bureau of Public Roads, give highway engineers a substantial start toward correcting two of the most annoying faults of gravel surfaced roads. Scarcely less important are the studies in North Carolina and Georgia of sand-clay and top-soil roads. In this research work three facts (1) the combination of clay and sand most stable under traffic, (2) the limit of traffic under which maintenance is practicable and (3) means of strengthening and toughening the surface layer, are approaching tentative determination. It appears quite certain that means may be at hand in the near future of extending considerably the durability of artificial and natural sand-clay roads.

Studies of tractive resistance have been notable. Two of these conducted at the Iowa State College are outlined in *Engineering News-Record*, Dec. 7, 1922, p.

982 and on p. 76 of this issue, and they reach noteworthy practical conclusions. With the equally comprehensive investigations of the University of Michigan, the studies of Major Mark L. Ireland, Q.M.C., and the tests at Yale University, results have been made available which give the highway engineer a good start in the economics of road surfaces, grades and alignment.

A traffic census remarkable for its magnitude and detail is under way in Connecticut in conjunction with the Bureau of Public Roads. With the records of this census analyzed, a task now in progress, engineers will have data and conclusions on commodity and passenger movement which will furnish a real basis for rational selection of road types. Incidentally Connecticut has conducted a census of highway accidents which is equally unusual in its scope and detail.

Only the high points of highway research have been touched. Significant as are their results they are less significant and inspiring than is the fact noted at the outset that nearly 500 research studies on highway engineering and highway transport are in actual progress in the United States in engineering schools, in state highway laboratories, in city and county laboratories, by state geologists and by industrial organizations. With the co-ordinating possibilities of the Advisory Board on Highway Research, which should function positively during the coming year, these many individual studies promise real usefulness.

Incidental to this highway research work there has been invention and adaptation of instruments and devices for conducting and recording tests. Individual mention of even the more unique of these apparatus is impracticable but the general statement can be made that highway research engineers have had virtually to create scores of instruments and testing apparatus of all kinds with which to work, before they could conduct the research studies which they have undertaken.

Development in Design—Advance in road design has been largely confined to the pavement slab. In all states there seems to be general satisfaction with the present grade cross-sections and finish. Use of standards is the prevailing custom. Very few states as general practice design roadbed for the specific project in hand or to meet the local variations in soil, drainage and location. To repeat, highway engineers appear to be satisfied with their present standard roadbed designs.

In pavement design a similar contentedness of mind does not prevail and there is development. Growing out of the service tests on the Bates road and the Pittsburg road there is a strong inclination to change pavement cross-section from a slab thick at the middle and thinner at the edges to one as thick at the edges as at the center or to one with edges much thicker than the center depth. The new concrete pavement section adopted in Illinois is the outstanding example of the change to strengthened slab edges. The technical significance of the new Illinois design deserves some consideration.

Test roads have seldom given results so positive that a radical change in pavement design has followed. The fact then that, following the Bates Road tests, Illinois will hereafter build its concrete road slabs with thick edges and a thin crown, is worthy of note as a variation from the normal. This change in practice is, however, significant in a broader way. The idea of a road pavement with thickened edges is not unique. Virtually the same design as has been adopted in Illinois was selected for the Maricopa County road system in Arizona as described in *Engineering News-Record*, May 26, 1921, p. 882. Also road slabs with their edges thickened have frequently been built in California and in other places. These designs have generally been regarded by engineers as erratic practice or as resorts to satisfy peculiar local conditions. The standard concrete pavement has invariably been conceived as a slab thick at the center and thinner at the edges. The new Illinois design for concrete pavement and pavement base is, therefore, a move toward a radical revision of a standard. Its second significant feature is that it is a design based on tests and mathematical analysis. It is an interesting effort toward the rational design of paved roads.

Mention that the new Illinois section for concrete road and concrete base is not entirely novel invites a few words of the history of paved road slabs strengthened by thickening at the edges. When Woodward Ave., one of the early Wayne County, Michigan, concrete roads, was paved in 1910, it was designed with inverted curbs or edge girders, in one piece with the slab. The design was never repeated in Wayne County and indeed was regarded as bad, so that when California in 1912 specified a slab with thicknened edges as an alternate design to be used when ordered and in 1914 constructed 7,000 ft. of road with thickened edges it was virtually the pioneer in employing this section for concrete roads. Maricopa County, Arizona, with its 300-mile concrete road system, all of substantially the same section as that just adopted in Illinois, was the pioneer user in quantity of thickened-edge concrete road.

A second design development worthy of note is the extension during the year of the use of longitudinal joints and doweled joints. Several states have come out with new designs differing in detail but alike in general character and dedicated to the same purposes: (1) reduction of longitudinal cracking, (2) reduction of traffic interruption during construction and (3) increased ease of construction. Concrete road with a center joint may be considered to have developed in 1922 into generally accepted good practice.

It has been noted that the development of thickened edges applies also to concrete base for brick or asphalt pavement. In other respects neither type exhibits any notable alterations purely in design. Perfection of material and progress in their simplification and standardization are to be observed. These are problems for the users of asphalt and brick roads to investigate this year. With the experiments now being concluded by the Bureau of Public Roads the engineer is promised means of improvement in bituminous surfaces.

Primarily, however, the pavement design advance of the year has been the possibility created by research of employing rational methods.

Construction Management Improved—Road builders accomplished no material advances in machines or in construction methods. There has been, however, a notable extension of machine operations particularly in grading. Tractor grading is coming to be common practice. Mixing and finishing machines show mechanical improvement but in general no material departure from precedent. Another year, however, is likely to tell a different story if devices now being perfected do what they promise. On the whole, the outstanding de-

velopments of 1922 in construction are broader in scope than improvement in detail of machines and methods.

An obvious conclusion from the year's construction is that road builders are becoming more competent in construction. In a season curtailed by bad weather they have accomplished nearly as many units of work as in the remarkably fair season of 1921. Other factors of course may have had influence but one does not presume too much perhaps in assuming that four years of intensive road building have created a corps of highway contractors of relatively high skill. The states are getting through their yearly programs more easily.

Two conditions curtailed the construction season. One was rain and the other was inadequate railway transportation. All the spring and through May and June and in some states well into July there was continued rain. Later good weather prevailed but in August operations began to be hampered by the coal strike and the shopmen's strike and then by the withdrawal of cars for handling coal and, later, the crops. Estimates based on general observation are uncertain but it is reasonably safe to say that the road building season of 1922 was only about 70 per cent that of 1921. In the last calendar year, however, the amount of work done was only slightly less than in 1921.

Growing out of inadequate transportation service last year and in several previous years except 1921, is the utilization of local materials which in 1922 reached perhaps its maximum development to date. Wisconsin, Pennsylvania and North Carolina have played leading parts in developing road-side gravel pits and stone quarries, but other states have not lagged in inaugurating the practice. It has become established during the last twelve months as a well-proved means both of reducing cost and of striking off the shackles of undependable railway service.

General improvement was recorded in contract practice. In general (1) the practice increased of letting contracts all the year round instead of largely in two months of the early spring; (2) risks and elimination of variables, such as variations in freight rates and changes in cement prices, were more generally undertaken by the states; (3) states more generally adopted the practice of paying estimates on materials in stockpile and warehouse on the job; (4) a step was made toward liberalizing contracts in the respects outlined in *Engineering News-Record*, Nov. 2, 1922, p. 749.

With all this progress and other effective movements to stabilize road contracting, contractors in general in 1922 miscalculated the conditions and undertook work at prices which gave little if any profit and often involved a loss. Some of the conditions which appear to account for this situation are reviewed editorially in this issue.

Maintenance Extended—Progress in highway maintenance in 1922 was expressed in four principal ways: (1) general extension through the adoption of systematic maintenance by more states; (2) increased practice of extending maintenance to entire main road system prior to constructing permanent grade and surfacing; (3) increased adoption of patrol maintenance with floating gangs for special tasks such as painting, installing signs, and bridge repairs; (4) general acceptance of the principle that financing for construction of improved roads premises financing and organization for the maintenance of such roads after construction.

Administration has been a matter for consideration by a number of states just entering into active improvement programs. Considering primary road systems, virtually the present state road systems, administration of maintenance is state, county, or state and county combined, with pronounced advocates of each but very few comparative facts to show which is preferable and under what conditions. Organization for maintenance makes it (1) a branch of the construction division or (2) a separate division. Again each has its advocates with pronounced views and no comparable evidence. All the forms of administration and organization which have been named are operating successfully in practice but again there are no facts by which comparative success is demonstrated. In brief, the whole problem of road maintenance administration has approached a phase this year where it requires elucidation.

As another phase of maintenance, the control of vehicle loads and speeds has inspired more activity in the last twelve months than ever before. As already stated, research in 1922 has demonstrated beyond question that without load regulation maintenance becomes nugatory for a road has no established life.

Again a new thought is presented by the action of certain states newly launched into the flood of intensive road improvement in establishing full primary highway maintenance before undertaking construction of the system. This procedure enables improved service over the whole system in the intervals between laying out the system and completing its improvement by permanent grade and surface. It is highly successful as a means of clinching the favor of the public.

The Task Ahead—Looking forward to the coming year, with the record of the past year in mind, certain lines of necessary activity appear to be indicated as follows:

1. Administration: Studies to fix general principles and policies relating to (a) the problem of securing efficient, well-paid, non-political highway organizations; (b) the problem of adequately and fairly financing the programs of construction and maintenance made necessary by the present and expected traffic; (3) the problem of co-ordinating highway transportation with railway transportation for the highest economic benefit of industry.

2. Organization: Perfection on the theory of highway improvement as a continuing business involving consideration of the problems of (a) advisory control, (b) executive direction and (c) personnel as influenced by adequate compensation, permanency of employment, opportunity for promotion.

3. Research: Extension along all of the lines followed in 1922 with particular attention to (1) traffic studies to determine economic types, (2) tractive studies to determine the economic theory of alignment, grade and surface, and (3) studies of gravel and earth road surfaces to determine limits of traffic and means of increasing durability.

4. Standardization: Extension of the standardization studies now in progress (1) on design of roadway and pavement, (2) on materials, and (3) on construction plant.

5. Simplification: Extension of the work of reducing the variety of materials now specified. The reduction of paving brick sizes from 66 to 11 is an example. Asphalt varieties require a similar reduction.

Practical Lessons from the Bates Road Tests

Paved Roads Will Fail Prematurely Unless Loads Are Controlled—Balanced Strength Requires Pavement Edges to Be Strengthened — Fatigue Failures Possible

COMPLETION of the traffic tests on the Bates test road in Illinois permit certain tentative conclusions which can be put to immediate use in designing paved roads. In general the tests have shown first that there must be strict truck-load regulation if paved roads are to endure, and second that greatest pavement endurance is secured by a slab which is considerably thickened at the edges. Both of these practices have been laid down as requisites for the future highway operations of the state of Illinois.

A description of the Bates test road and details of the construction of each section were published in *Engineering News-Record* of Aug. 18, 1921, p. 274. In the issue of Aug. 10, 1922, p. 236, the results of the traffic tests up to and including the fifth increment of loading were published. Briefly, the plan of the traffic test was to impose on the two-mile road consisting of 63 different sections of pavement, a loading shown in the table on Page 60. Eighteen 3-ton trucks were used for applying the loads. The accompanying sketches of the layout of the sections give an idea of the present condition of the road. Views of all sections are also shown. These pictures were taken after the completion of all of the traffic runs.

Beginning with the completion of the Bates Test Road in 1920 and continuing through the traffic tests of 1921, frequent progress reports and discussions have been published by the Division of Highways of the Illinois Department of Public Works. The final report has not been completed. The conclusions and discussion in this article have been assembled from the progress reports, and all have the authority of the department officials, Clifford Older, state highway engineer, and Frank T. Sheets, superintendent of highways.

Tentative Conclusions—With the completion of the tests the greatest traffic imposed upon any section was 377,460 tons. Of this 198,000 tons were imposed by trucks loaded to the legal limit of 8,000 lb. on each rear wheel. Only nine of the original 63 sections came through without a break. Since four of the sections had breaks which were obviously caused by abnormal conditions, thirteen sections may be considered as having satisfactorily sustained the traffic test. The final records are not yet fully analyzed, but certain general comparisons and tentative conclusions are possible.

1. A difference in the thickness of base, thickness of brick or type of brick, apparently had no consistent effect upon the load-supporting capacity of bituminous filled brick on macadam base. All five sections failed at approximately the same time and to the same extent. This does not seem logical and studies will be made in an effort to fix the cause of the apparent inconsistency.

2. No consistent ratio of strength to thickness of base appears in sections of asphaltic concrete on macadam base. Apparently traffic-supporting capacity increases with an increase in thickness of asphaltic concrete top.

3. The assumption made at the beginning of construction that an asphaltic concrete wearing surface on a concrete base would have a traffic supporting capacity equal to that of a concrete pavement having a thickness equal to that of the base plus 1-in. seems to have been a fair guess. Additional thickness of top apparently adds strength to the pavement. It is further evident that increased base thickness is accompanied by increased strength.

4. Wide variation is noticed in comparing sections having the same base and top thickness, but having lean and rich base mixes.

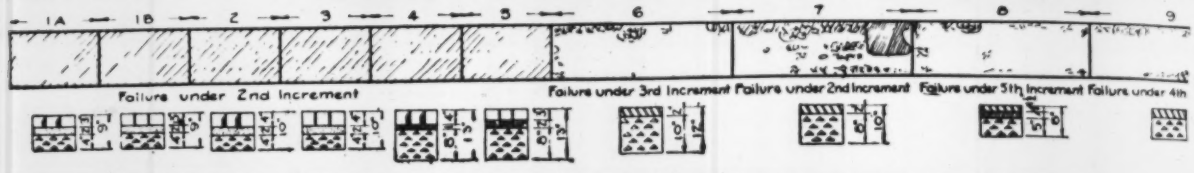
5. The original assumption that a bituminous-filled brick wearing surface on a concrete base has a strength equal to that of a concrete slab having a thickness equivalent to that of the base plus one-half the thickness of the brick surface was apparently incorrect. In practically every instance the concrete sections proved of greater strength than their supposed equivalent in bituminous filled brick.

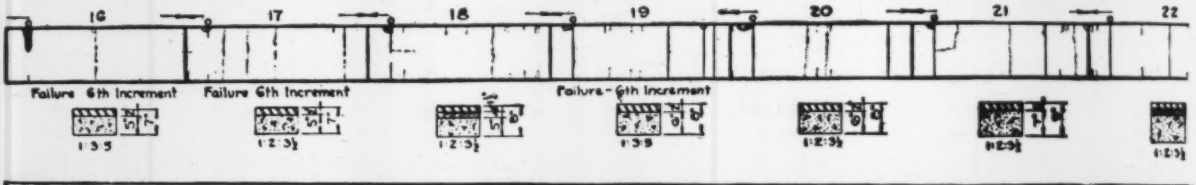
6. There appears to be no obvious difference in the resulting strength of the two kinds of brick (lug and lugless), the bases being the same. In each case the artificially-made in the part of the sections laid with lug brick; and to this fact is attributed the greater number of breaks occurring in the sections of this type. Had these joints been cut in both the lug and lugless sections, it is believed the breaks would have been equal in number in both types of brick sections.

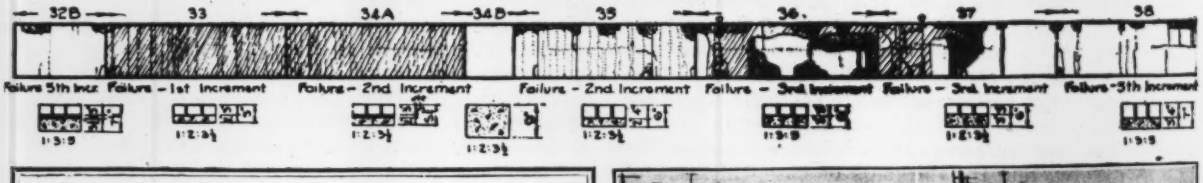
7. Although no direct comparisons can be made between 3-in. and 4-in. brick, the bases being the same, the indications are that the added inch of brick is probably effective in producing greater strength. In comparing sections where the total thickness of the pavement is about the same, but variations are present in the thicknesses of the base and brick surface, a great inconsistency is noticed. The comparative effect of rich and lean base mixes seems also to be inconsistent.

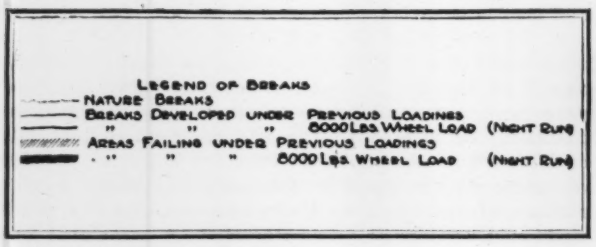
8. In comparing the various cushions which were used under the surfaces, it seems to appear that the mastic cushion (in this case 10 per cent Tarvia B mixed with sand) is superior to the sand and sand-cement cushion. In regard to the use of sand and mastic cushions, it can be said that previous to the application of traffic on the road, a difference was noted in the surface of the brick in these sections. In the sand-cushioned sections it was noted that an occasional row of brick across the entire width of pavement had settled immediately over a crack in the base. It is thought that this settlement was due to the sifting of the sand from the section through the crack. Although cracks were present in the base of the mastic-cushioned section the cohesiveness of the cushion prevented any sifting

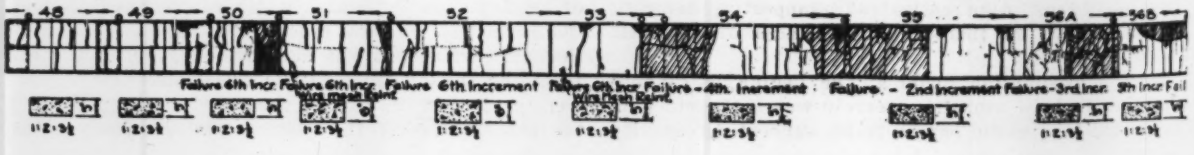
BATES ROAD TEST TOLD IN PICTURES



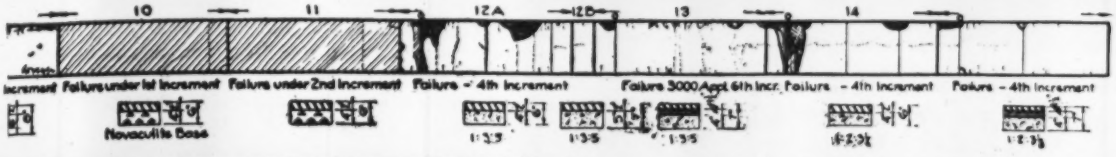




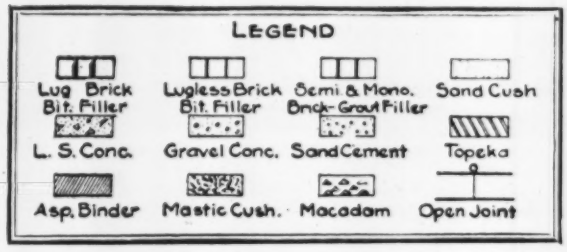

LEGEND OF BREAKS
NATURE BREAKS
BREAKS DEVELOPED UNDER PREVIOUS LOADINGS
" " " 8000 LBS. WHEEL LOAD (NIGHT RUN)
AREAS FAILING UNDER PREVIOUS LOADINGS
" " " 8000 LBS WHEEL LOAD (NIGHT RUN)

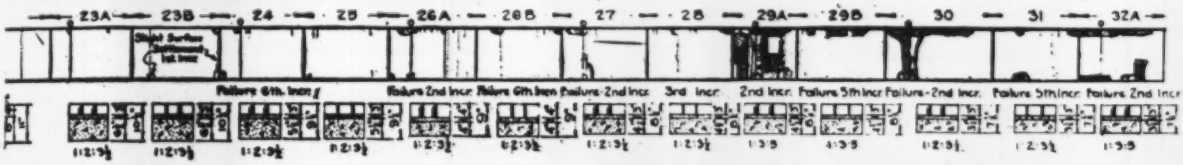


SEC. 8-9.
SEC. 10-11.
SEC. 12-13.
SEC.-14.


10
11
12A
12B
13
14
Increment
Failure under 1st Increment
Failure under 2nd Increment
Failure - 4th Increment
Failure 3000 Appl. 6th Incr.
Failure - 4th Increment
Failure - 4th Increment
Novaculite Base
1:3:5
1:3:5
1:3:5
1:2:3½

SEC. 25-27.
SEC. 28-30.


LEGEND
Lug Brick Bit. Filler
Lugless Brick Bit. Filler
Semi & Mono. Brick-Grout Filler
Sand Cush
L. S. Conc.
Gravel Conc.
Sand Cement
Topeka
Asp. Binder
Mastic Cush.
Macadam
Open Joint


23A
23B
24
25
26A
26B
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28
29A
29B
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31
32A
Failure 6th. Incr.
Failure 2nd Incr.
Failure 6th Incr.
Failure-2nd Incr.
3rd Incr.
2nd Incr.
Failure 5th Incr.
Failure-2nd Incr.
Failure 5th Incr.
Failure 2nd Incr.
1:2:3½
1:2:3½
1:2:3½
1:2:3½
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1:2:3½
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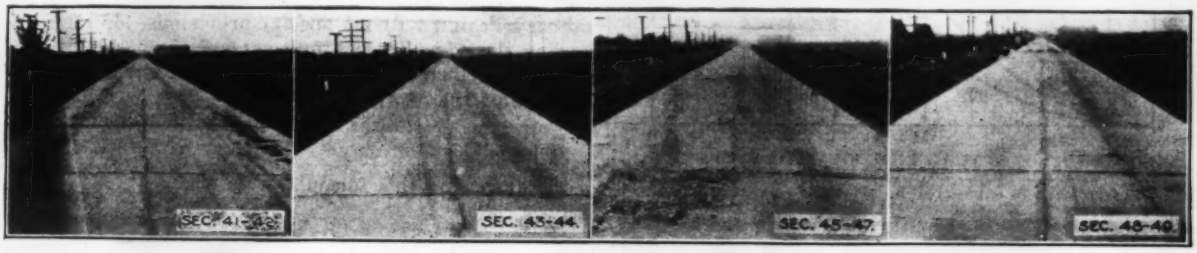
SEC. 41-42.
SEC. 43-44.
SEC. 45-47.
SEC. 48-49.

39
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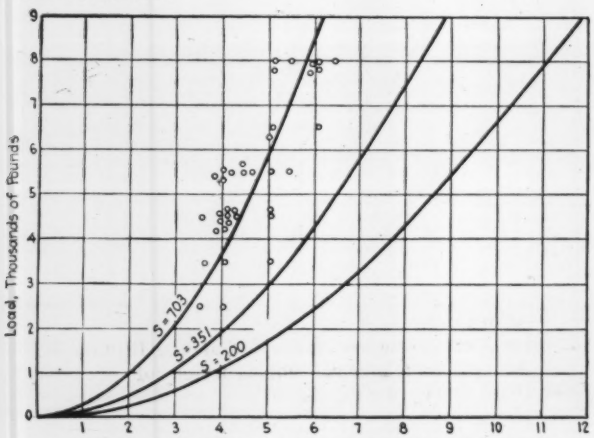
46
47
Failure - 5th Increment
Failure 5th Incr.
1:3:5
1:2:3½
1:2:3½
1:2:3½
1:2:3½
1:2:3½
1:2:3½
1:2:3½
1:2:3½

SEC. 56-57.
SEC. 58-60.
SEC. 61-62.
SEC. 63.

57
58
59
60
61A
61B
62
63A
63B
Failure - 3rd Increment
Failure - 4th Increment
Failure - 2nd Increment
Failure - 3rd Increment
Failure-2nd Incr.
3rd Incr.
Failure - 3rd Increment
1:2:3½
1:2:3½
1:2:3½
1:2:3½
1:2:3½
1:2:3½
1:2:3½
1:2:3½
1:2:3½

of the material, with the result that no settlement in the brick took place.

9. The original assumption that the brick surface in monolithic pavement acts as a unit with the concrete of the base, thus forming a truly monolithic slab having the same carrying capacity as an equal thickness of concrete, was disproved early in the traffic tests. Before the truck traffic was started, a number of areas were recorded where the bond between the grout-filled brick surface and the base was distinctly broken. Additional areas of this character continued to develop during the test. Under the trucks, the brick surface and the base in these areas acted as independent superimposed units in supporting the loads. The brick surface usually failed first by a shattering of the bond between the individual bricks, the base then being called upon to support a much greater proportion of the total load. Usually base failure soon followed. It was clearly evident that the strength of a so-called monolithic section was less than that of a concrete section of the same thickness.



LOCATION OF ACTUAL BREAKS WITH RESPECT TO THEORETICAL BREAKING LOAD CURVES

Points related in same position relative to average modulus of rupture of all sections as they occur relative to the average modulus of rupture of the particular type they represent.

10. In comparing the value of an added inch of brick with an added inch of concrete base, the total thickness remaining the same, it was noticed that the thicker base section has the advantage.

11. An increase of total thickness appears to add strength. That is, a 4-in. brick on a 2-in. base shows greater strength than a 3-in. brick on a 2-in. base.

12. Indications are that a richer mix of concrete in the base is better than a lean one.

13. Soon after starting traffic, it developed that the sections containing special cements or other chemicals showed less strength than the plain concrete sections of the same thicknesses.

14. Sections containing certain special features of design, consisting of transverse and longitudinal joints with marginal steel, showed greater strength than the plain concrete sections of the same thicknesses.

15. A comparison between the sections having imbedded steel gives the impression that the sections containing wire mesh showed the least strength for their thicknesses.

16. Sections containing wire mesh seemed to show some indications of greater strength than plain concrete having the same thickness.

TABLE I. LOAD INCREMENTS AND THE NUMBER OF APPLICATIONS OF EACH

Increment No.	Load Lb. on Each Rear Wheel	Load Lb. on Each Front Wheel	Gross Load	Net or Live Load in Lb.	Number of Round Trips Day	Night
1	2,500	2,250	9,500	.....	1,000	
2	3,500	2,150	11,300	.....	2,167	1,033
3	4,500	2,000	13,000	1,700	2,000	1,000
4	5,500	1,900	14,800	3,500	2,000	1,000
5	6,500	1,800	16,600	5,300	2,000	1,000
6	8,000	1,930	19,860	8,560	5,000	5,000

17. A comparison of sections containing longitudinal control joints and those in which no joint was placed appears to give the former the advantage of strength.

18. In the plain concrete sections the thicknesses of the slabs were a measure of their strengths.

19. *The behavior of all of the 63 sections demonstrates the fact that if traffic can be kept away from the edge of the pavement, fewer failures will result.* Under every increment of load, except the first, the number of failures occurring on the south side exceeded to a very great extent those on the north side. The line of traffic in all runs except the first, was such that the outer rear wheels of the trucks traveled 2½ ft. from the edge of the pavement on the north side and directly on the edge of the south side.

Strength Theory of Rigid Pavements—In *Engineering News-Record* of Feb. 3, 1921, p. 210, Clifford Older, State Highway Engineer of Illinois, called attention to the apparent weaknesses of rigid pavements at corners formed by the intersection of transverse cracks or joints with the edges of the pavements. A tentative formula for pavement design was suggested which was based on the assumption that such corners should be designed as unsupported cantilevers. This formula for slabs of ordinary design without special provisions for strengthening the edges was as follows:

Stress equals three times the load divided by the square of the depth of the slab:

$$S = \frac{3W}{d^2}$$

Transposing this formula,

$$W = \frac{Sd^2}{3}$$

If, then, the assumption upon which this formula is based is true, by substituting for S the modulus of rupture of the load-carrying element of the slab design, the breaking load for any thickness may be determined.

It is interesting to compare the behavior of the rigid sections of the Bates road with this formula.

In the figure the theoretical breaking load curve is plotted on the basis of the average modulus of rupture of the test pieces of all concrete sections and all others having concrete bases. The breaking load points in this diagram are plotted in the same horizontal position relative to this breaking load curve as they hold to the average modulus of rupture curve of their respective series. It is noticeable that even as so plotted, the points fall in rather a wide band. Such an occurrence is inevitable considering the fact that even in carefully controlled operations, accidents of construction may influence the strength of the pavement slab. Further, the temperature conditions affecting the closing of transverse joints and cracks, therefore greatly affecting the carrying capacity of the weak corners, tend to produce erratic results. Again, the load increments vary one from the other by rather wide stages, which might easily mean that the critical load for a

given thickness was less than the one recorded. No attempt was made to take this factor into account in evaluating the critical load breaks, as previously described. The figure shows also a curve in which the load causing fiber stress equal to that of one-half of the average modulus of rupture is plotted against the thickness.

The fatigue tests which have been carried on by the Illinois Division of Highways for about 18 months indicate conclusively that concrete may resist bending loads indefinitely if such loads do not cause fiber stresses in excess of one-half of the modulus of rupture of the concrete. Inasmuch as it was impossible to operate the trucks a sufficient number of trips for each increment to cause fatigue, the plotted points in all diagrams without doubt are but little effected by fatigue breakage. The laboratory tests show that where the loads applied produced a fiber stress of from 5 to 10 per cent in excess of one-half of the modulus of rupture, fatigue may not follow for from 5,000 to 40,000 repetitions. Loads which produce fiber stresses in excess of 60 per cent of the modulus of rupture are usually followed by breakage after a comparatively few repetitions.

It seems safe therefore to conclude that had the number of applications of each increment been much greater—say 30,000 to 40,000—the breaking load points would have fallen in the main between the curve passing through points representing a fiber stress of 703 and that representing a fiber stress of 351.

In the figure is also plotted a curve representing a fiber stress of 200 lb. per square inch which was proposed as a working formula in 1920. Had the various sections of the Bates Road been designed in accordance therewith, no breakage of any kind would have appeared under increments equal to the designed load. In none of the sections of the Bates Road, except 63A and 63B, which represent the Illinois 1921 sandard, was provision made for strengthening corners by doweling.

While the theory on which this formula is based is perhaps not yet fully established, nevertheless the empirical data furnished by the traffic tests seem to be sufficiently confirmatory to justify its use at least until something better is found.

By means of one or more continuous dowel bars along the edge, it is believed that adjacent corners may be made to act together and thus the breaking and working loads may be increased materially, or perhaps even doubled. Further, it is easily conceivable that if in addition to dowel bars the edges are thickened, they may be made stronger than other portions of the slab. It is, then, important to determine where next to look for trouble; and eventually determine how the slab should be designed for balanced strength throughout.

Safeguards for Existing Pavements—Many miles of pavement now in service are directly comparable with the Bates Road sections plotted in the figure. It is therefore not unreasonable to expect such pavements to show corner breakage when the load-thickness relationship here shown prevails. Further, the behavior of the test sections shows that loads much in excess of the critical load, as determined by the theoretical curve, are almost sure quickly to cause serious progressive destruction.

It would seem difficult to eliminate the danger entirely. It is suggested that shoulders of gravel, macadam, concrete or other material which could be constantly maintained, preferably slightly higher than the permanent edge, would help. Such shoulders would ordinarily prevent wheel loads from being applied to the extreme edges of the slab and thus tend to reduce bending stresses. Center traffic lines also help because where such lines exist drivers concern themselves only with keeping their vehicles on the proper side of the line. Without such lines they crowd to the outer edge of the pavement to make sure to clear passing vehicles.

Heavy triangular corner repairs of rigid material will also help, as the obtuse-angled corners of the adjacent old slab will carry greater loads than right-angled corners.

Limiting the loads to the strength of the slab would of course solve the problem for old pavements.

Suggestions for Improved Designs—Designs for new pavements should provide for strengthened edges.

This may be accomplished by providing integral curbs which would not only strengthen the edge but largely prevent wheel loads from being applied to the extreme edge. It is believed that wider pavements, with integral or inverted curbs, using no more or even less material than is now used in many designs, would afford equal or possibly greater load-carrying capacity.

Merely increasing the width would undoubtedly prolong the life by reducing the frequency of the passing of heavy wheel loads off and on, and along the edges.

Longitudinal joints in concrete pavements reduce the warping due to changes of temperature, thus increasing the possibility of subgrade support along the edges under night traffic. Such joints should be provided with tie bars to prevent spreading, and a corrugated or tongue-and-groove effect so that the adjacent slabs would afford mutual support.

Illinois New Design—The terms of the Illinois Bond Issue Act prevent general construction of pavements wider than 18 ft. Integral curbs on pavements of this width would probably inconvenience traffic and for this and other reasons are not generally used. To increase the edge strength, the new Illinois design provides for a 9-in. edge thickness, tapering to 6-in., at 2 ft. from the edge. The edge is also strengthened by a continuous ¾-in. round smooth bar. The rest of the slab is uniformly 6 in. thick. A tongue-and-groove longitudinal joint is provided across which deformed tie bars are placed.

Four sections of this type have been added to the Bates Road, and will be tested by truck traffic early next spring. It is confidently believed that the results will show this design to have an ample factor of safety for the Illinois legal limit loads.

Rapid Progress in Selecting Federal-Aid Roads

The selection of the roads to compose the system of Federal-aid highways which will reach into practically every county of the United States is progressing rapidly. The system will comprise approximately 187,000 miles, and consist of not more than 7 per cent of the total road mileage in any one state. Not more than three-sevenths will be primary or interstate highways, and the remainder secondary or inter-county highways. This program of road construction will cover a period of from 15 to 20 years, though many states will complete their mileage in a much shorter time as they have included in the system a considerable mileage of improved road. They will then enlarge the Federal-aid system by including additional mileage.

The Labor Shortage—Its Volume and Means of Relief

How the Wastes of Seasonal Employment Are Being Studied and How Apprentices Are Being Procured for the Building Trades

In the issue of January 4, the first section of this series contained two articles; the first, "How Great Is the Shortage of Building Trades Workers," and the second, "Immigration as Affecting the Labor Situation." The two articles herewith complete the series.—EDITOR.

How Are the Building Trades Training Apprentices?

BY FRANK L. GLYNN
Managing Director, New York Building Congress

THE fact that Europe has ceased to be the training school for the United States has brought about an acute situation in the building industry which is being reflected in all the basic industries contributing to a finished structure from the mining of the coal to the manufacture of hardware, tile, glass, electric fixtures, heating apparatus and the hundred and one necessities upon which a contractor is dependent.

This situation is due to the neglect on the part of the building industry to perpetuate itself by providing means for training skilled labor. It is particularly unfortunate that this neglect has only begun to be realized at a time when the demand for building is at its highest peak, with indications that this peak will be maintained for some time to come provided there is enough labor to do the building. Nor has the responsibility for the discouragement of building trade apprentices rested all with the unions. Employers in the past have put obstacles in the way of apprentices getting ahead. As long as young men were apprentices they got apprentice wages. The more they learned the more would be the wages and it was not to the interest of the employer to enlarge his payroll.

The Wisconsin Law—The only apprenticeship law now in force in the United States is in Wisconsin, which, for more than six years, has provided for apprenticeship contracts under the administration of the State Industrial Commission. These contracts embody the signatures of the parties to the contract, the date of beginning apprenticeship, the period of its duration, the processes or particulars of the trades to be taught and practiced, the wages to be paid and any other special arrangements customary in the trade.

The law requires, furthermore, that the apprentice shall attend an apprenticeship school for supplementary trade instruction five hours per week on the employer's time where such schools are established. It is required by law that such schools shall be established in all cities of more than 5,000 and may be established in smaller cities. These schools are supported entirely by public funds. They are designed to give academic trade instruction to the boy as well as to afford him trade experience in the shop.

Penalties are provided for violation of the contract which will involve a fine of from $1 to $100 for either party; in addition, the regular penalties follow for the violation of the orders of the Industrial Commission which have the same standing as any other orders of that commission.

But despite the slowness of the building industry throughout the country to arise to the needs of this situation, it has now come to realize the necessity for far reaching and fundamental changes. The need of more apprentices in the building trades has become so obvious that, in many cities throughout the country, there are being worked out definite programs for the training of mechanics. This plan is well under way in New York, Boston, Chicago, San Francisco, Philadelphia, Cleveland and Portland, Ore., and is in process of development in Detroit and St. Louis.

The New York Plan—In New York, to take a specific case, the administration of the plan is in the hands of the Apprenticeship Commission of the New York Building Congress and already it has been applied to two of the trades. The program is outlined as follows by Stephen F. Voorhees, president of the congress:

> We have been giving our attention to the shortage of skilled labor in the building industry for the past year, and have worked out a plan in entire co-operation with all the elements of the industry including architects, realtors, engineers, contractors, material manufacturers, bankers, and organized labor. We have worked together until now we have a going commission in charge of providing opportunity for the young men of this locality to learn the skill required by mechanics in the building business. Formerly we were able to draw on Europe for our skilled workers. This has now stopped and we must make them. The basic idea is close co-ordination with the public school system both in offering an opportunity for graduate students to enter the industry and to provide the necessary technical instruction that goes with our development and is a vital part of it.

The plan in force in New York provides for a four-year apprenticeship during which practical daily work is supplemented by evening instruction under the supervision of the public school administration. The training comprises five and one half 8-hr. working days per week continuously and four hours evening instruction weekly for a period of 38 to 40 weeks per year. The New York City Board of Education has made a specific appropriation of $20,000 for this work during the fiscal year 1922-1923. The Apprenticeship Commission places the apprentices through co-operation with the placement department of the public schools and with the employers, and exercises a continuing supervision in order to insure that the boy keeps up with his studies and that the employer gives him the graded work necessary for his training.

How Agreements Are Made—The apprenticeship agreements are negotiated by conferences between the commission and joint trade committees composed of representatives of the trades unions and the employers. The commission itself consists of five representatives of the building trades unions, five employers, and three neutrals who are interested in building construction but who are non-partisan as between the unions and the employers. In all the conferences with the various

trades, this commission represents the congress, but each of the trades has its own joint trade committee. When satisfactory standards of apprenticeship have been drawn up, they are ratified by the joint trade committees and incorporated in the trade agreements.

The ratio of apprentices in each trade is determined as a result of an exhaustive study of seasonal employees in the building industry in the metropolitan district, in the course of which 93,000 cases were studied for each year of a ten-year period. This is a matter of the utmost importance, for an essential feature of the apprenticeship plan is continuity of employment, which could not be realized if the number of apprentices were excessive. This difficulty is accentuated in the building trades because of its seasonal nature. Although it is planned to allow four years in which to bring the plan into full operation, the ratios in each case have been based upon 50 per cent of the lowest rate of employment, thereby allowing for a falling out of about half of those that start.

A Specific Case—As an example of how this plan works out in a specific case, the apprentice ratio for the painting and decorating trades for the first year has been placed at 140 apprentices to a total of 8,000 journeymen. The apprentices must be between 16 and 21 years of age and are required to put in a probationary period embodying the first two weeks of employment. Advanced credit is allowed to apprentices for previous trade experience or for work in an approved school subject to rating by the joint apprenticeship committee of the trade.

The wages of an apprentice are for his first year 33⅓ per cent of the beginning journeymen's wage, for the second year 44⅘ per cent, for the third year 55⅝ per cent, and for the fourth year 72⅔ per cent. For the time spent in the school the employer allows the apprentice one-half the regular hourly wage rate. Apprentices who do not keep up their school work are subject to discharge by their employers and to exclusion from membership in the unions.

The subjects taught in the schools include related mathematics, trade sketching and drawing, shop practice, related science and general information. In his work, the apprentice is taught the processes and the care and use of the tools used in the painting and decorating trade.

The Industry Supports the Plan—Both employers and trades unions are loyally supporting this plan, as they have been brought face to face with the necessity for bringing young men into the trade and for giving them a thorough training in order to maintain the high degree of skill established by the industry, which heretofore has depended more or less upon skilled workers coming from European countries and has neglected the training of the younger workers.

In the last few years intensive training, vestibule schools, etc., have been turning out specialized workers who are able to do some particular jobs, but these workers do not know the relation of their work to the finished product. Experience has proved that these so-called quick methods of training workers have failed to produce trained mechanics.

A trained mechanic is a man who has had practice, experience and instruction in the various processes of the trade. He knows the various processes of the trade, the relation of one process to another and to the finished product. He can perform his work with an economy of material, a high degree of accuracy and in a minimum period of time. These factors of experience are accomplished by the co-ordination of the hand, the eye and the brain, and the proper functioning of these factors is only brought about by well directed apprentice training.

Employers are in favor of apprentice training as they know a trained mechanic is an asset to the industry. He earns the wages he receives, he goes about his work in a business-like way without the necessity of a highly paid foreman telling him every few minutes what to do and how to do it. He can stand on his own feet. Organized labor is in favor of a well-directed apprenticeship plan as well-trained workers can maintain wages commensurate with the quality and quantity of work performed. Such workers take a pride in their work and raise the standard of their trade to a higher plane whereby the craft has the respect of the community. The public favors well-trained workers because it knows that when work is performed by trained journeymen, it receives full value for money expended.

This is essentially the apprentice problem in one of the great building trades. As the workers go up the ladder a round a year and leave the ladder altogether after the thirtieth round, new men should be mounting behind them. But at the present rate of apprenticeship replacement those lower rounds are soon going to be empty, and before very many years have passed only a few of the upper rounds will be occupied.

* * *

Seasonal Employment in Building Construction

By D. Knickerbacker Boyd
Architect and Structural Standardist, President, Philadelphia Building Congress

More possible working days are lost by workers in the building "trades" than by those in almost any other industry. The year's work is literally "shot to pieces" by intermittency due to unemployment, not only from seasonal causes, which for the most part could be overcome, but from other causes many of which are related. Among them is (1) indoor work so often unnecessarily required to be done in warm weather and in a crowded construction period when it could be deferred till colder weather and a lowered employment period; (2) demolition not being started until the time of the year that the new construction which replaces the old should itself be under way; (3) lack of foresight in ordering or assembling materials or fabricated products in advance of construction needs; (4) delays in closing contracts with sub-contractors (sometimes unfortunately due to the other unfair practice of "shopping" for lower estimates).

Two of the most potent causes for lack of employment in localities subject to varying degrees of cold and possible inclemencies of the weather, say in December, January, February and March, are: (1) the psychological attitude of the building public towards starting anything in advance of this period of the year due to lack of concerted effort on the part of the contractors in each locality to convince themselves and the public through foresight and practical demonstration that construction can be advantageously carried forward by overcoming climatic handicaps; (2) the failure of employers, workers and others interested, to settle defi-

nitely, not later than say October 1, the scale of wages which will prevail for all the building trades in that locality on and after the beginning of the next calendar year and throughout the year.

And while we are speaking of scales it would be interesting to see if all manufacturers and dealers in each locality would settle upon prices at which deliveries would be made throughout the year instead of by the operation. With the knowledge of all costs fixed in the minds of investors and building owners in October for the next fifteen months, winter construction would become very popular with all those desiring to avoid the "spring rush." Thus would year-round construction become an economic accomplishment.

There are several things which must be done toward eliminating the great unemployment waste in the building and construction industry. Let us consider three of them in the following order:

TABLE I—DISTRIBUTION OF TIME FOR 1920 IN PHILADELPHIA BUILDING TRADES

Trade	Full Saturdays off	Half Saturdays off	Recognized Holidays	Possible Effective Working Days	Average days Worked Per Year	Total days Lost
Asbestos workers	0	52	6	281	185	96
Bricklayers	10	42	7	275	182	93
Stonemasons	10	42	7	275	185	90
Electrical workers	0	52	6	281	216	65
Elevator constructors	0	52	6	281	216	65
Engineers	0	52	6	281	200	81
Firemen	0	52	6	281	200	81
Granite Cutters	0	52	6	281	180	101
Lathers, wood, wire and metal	0	52	7	280	190	90
Plasterers	52	0	6	255	170	85
Plasterers Helpers	0	52	6	281	180	101
Cement Finishers	0	52	6	281	176	105
Painters	52	0	6	255	182	73
Paper Hangers	52	0	6	255	182	73
Plumbers	16	36	5	273	200	73
Riggers	0	52	6	281	176	106
Composition Roofers	0	52	7	280	182	98
Slate and Tile Roofers	0	52	7	280	170	110
Sheet-metal Workers	0	52	7	280	185	95
Steam Fitters	0	52	6	281	180	101
Iron Workers	12	40	6	275	152	123
Stone Cutters	0	52	7	280	180	100
Upholsterers	0	52	6	281	225	56
Tile Setters	0	52	5	282	200	82
Tile Setters' Helpers	0	52	5	282	200	82
Building Laborers	0	52	6	281	217	64

Note: Plasterers, painters and paper hangers have a 40-hour week the year round; no Saturday work. Stonemasons, bricklayers and carpenters have a full day off on Saturdays in July and August and Saturday before Labor Day. Plumbers have a full day off on Saturdays of June, July, August and September; half-days on Saturdays the balance of the year. Iron workers have full days off on Saturdays of June, July and August. All other trades work 44-hour week, 8-hour day, 4 hours on Saturday the year round, except building laborers, who work 50-hour week, 9-hour days and 5 hours on Saturday. On some work the building laborers do not have Saturday half-days off. The 52 Sundays have been eliminated. Recognized holidays are considered as falling on other than Saturdays.

1. Secure results through studies as to the effect of weather conditions on various kinds of buildings under construction so that intermittency of employment due to the interference of the elements could be promptly and co-operatively prevented by the promotion of better methods and management to decrease all such as could properly be overcome by the reasonable use of commercially possible precautions.

2. Secure the co-operation of building owners, managers, and tenants in bringing about a more equitable distribution of requirements in maintenance, alterations and equipment in existing buildings as distinguished from new construction so that the wasteful effects of intermittent employment could be greatly reduced as a corollary of seasonal occupation.

3. Inform the public in no uncertain way as to the nature, extent and costliness of the unemployment waste. Through this means and demonstrations as above to secure the co-operation of public, corporate and private ownerships in a sensible distribution of their new construction requirements in each region.

Individual contractors, aside from large regionally distributed construction concerns which are already realizing some of the possibilities, cannot without public appreciation and support cope with the first of these alone and building owners should not be greatly criticized for failure to co-ordinate their maintenance work with low employment periods because the building construction industry as a whole has until very recently been sadly neglected by those constituting its component groups. The "readiness to serve" burden of expense, due to waiting for public recognition of construction needs, has been allowed to grow to present bounds with little or no check. At last the public has become aroused to the high cost of construction for which it, in itself, is in a large measure responsible.

The existing pronounced shortage of building workers has at last caused recognition of the fact that their ranks have been decreasing for years past to an alarming extent. This in the face of increasing demands for their services and constantly rising wages has brought with it a realization that something is wrong, and that steps must be taken to recruit the ranks.

The usual procedure has been to establish courses for training apprentices which while apparently a wise move has not succeeded as it should. There are several reasons for this, the most potent being that present mechanics discourage young men from entering the crafts, as I prefer to call them rather than trades, because of the lost time which apparently accentuates the hazards and hardships.

Many young men, none too anxious to take up manual labor, especially outdoors, heed such advice without seeking inspiration for entering a calling in which they do not appreciate the possibilities for individual expression through real craftsmanship, nor comprehend the joy of achievement in what can be, and should be, an art and not a mere job.

The "job" of the building "craftsman" must, then, be made more attractive. One sure way to help in doing it is to eliminate as much lost time and idleness as possible. The industry must come to its own rescue and the public which has a vital stake in the enterprise must co-operate in the industry's program. The Building Congress movement shows the way out locally, regionally and inter-regionally, and if encouraged and co-ordinated by the American Construction Council will nationalize it and the industry. First in Philadelphia, then in Boston and finally on a more comprehensive scale by the New York Building Congress data on lost time have been assembled in all the building trades and the peaks and depressions in each charted.

It is high time that through such agencies, with the full co-operation of employees—familiar with the turnover and other special problems of the building industry—and skilled workers in the industry in each locality the U. S. Department of Labor, Bureau of Statistics, and the American Construction Council when functioning, be provided with accurate data for informing the public as well as all other trades that the basic wage paid skilled building mechanics is not so much higher than that paid other workers who have steady employment and receive 52 envelopes each year without loss of pay for holidays. Those who receive regular pay regardless of holidays or illness would not relish being docked for Christmas and other important days as are workers in the building trades and in such other trades as are paid only by the hours actually worked, rain or shine, ill or well.

Regular workers also usually receive each year one, or two weeks vacation with pay. But how different it is with the oft none-too-easy job of the construction worker. Instead of a reasonable annual rest period with pay, he gets an enforced leave of absence eight to ten times as long as the usual vacation period and without pay.

Because of the fact that wages actually received are only on the basis of hours actually worked (subject to the whims of some foreman, the caprice of the elements, or to transportation delays) there is insufficient incentive on the part of some employers to eliminate unemployment or on the part of some of those employed efficiently to complete one job and take chances on promptly securing another, especially in seasons or localities where it is known that intelligent foresight is not being exercised to avoid intermittency.

Several leaders of labor in the building construction industry have made the positive assertion to the writer that if they and their workers were convinced that other groups were sincerely co-operating with them to afford them more days in which to work and fewer in which to be idle, they would welcome the opportunity to maintain their efficiency—and would do more!

They have made the candid and almost obvious statement that if they had an actual demonstration over a period of two average years that the unfortunate, unpleasant and expensive circumstances attendant upon idleness would disappear except on holidays for which they lose wages they would voluntarily reduce their hourly wage rate as a compensation for the relief from "fear of unemployment" and be better off each year in spirits as well as in finances.

In addition to the satisfaction to be derived through such a use of time formerly lost—one thing which when gone can never be replaced—the saving to the building public would be enormous.

If figured at an average of 20 per cent on construction labor, this one item alone would take approximately 10 per cent off the cost of any home or building and leave each worker better off physically, mentally and financially at the end of every normal year of construction.

In 1920 and 1921 with the co-operation of the Philadelphia building trades and W. S. Hays, later secretary of the National Federation of the Construction Industries, there was made the first study of lost time in the building industry in any given locality. The figures have recently been brought up to date preparatory to another survey and it is expected that contractors and sub-contractors as well as labor will co-operate.

An advance copy of the preliminary report of a Committee to the Philadelphia Building Congress is here abstracted for the benefit of readers of the *Engineering News-Record* in the hope that the data may prove of value in other localities also and will afford a stimulus for similar studies elsewhere.

In making these calculations, there were first deducted from the 365 days of the year all Sundays, all holidays observed in the trade under consideration, and the number of full days lost through the custom of trade in regard to work on Saturday. What remained was called the number of possible effective working days. From this was then deducted the time lost through unemployment, the time lost—and unpaid for—on the job through delay in the delivery of materials or through other causes for which the worker is not responsible, the average time during which weather conditions prevent work, and the average time lost through illness and absenteeism. The remainder was taken as the average time worked during the year. No deduction was made for the time lost through labor troubles; the "average days worked per year" represent what a man might expect if he took no part in strikes or lockouts, worked whenever weather permitted and he could get work to do, and had average success in securing employment. The results thus arrived at for the various trades are as given in Table I.

On the basis of these preliminary figures, the average annual income of the building trade workers in Philadelphia can be calculated. Taking the hourly rates paid in the various building trades, as compiled by the National Association of Builders' Exchanges and as representing conditions prevailing Sept. 30, 1922, and applying them to the data concerning average number of days worked in a year, Table II is obtained, in which the theoretic annual earnings represent what the worker would receive if he were employed for the full number of possible effective working days, and the average annual earnings show what he would receive if employed for the average number of days worked per year in his trade.

TABLE II—WAGE RATES AND ANNUAL EARNINGS IN BUILDING TRADES OF PHILADELPHIA

Trade	Hourly Rate	Daily Rate	Theoretic Annual Earnings	Average Annual Earnings
Bricklayers	$1.25	$10.00	$2,750.00	$1,820.00
Stone Masons	1.10	8.80	2,360.00	1,628.00
Electrical Workers	.90	7.20	2,023.20	1,555.20
Elevator Constructors	1.06	8.48	2,372.88	1,831.68
Engineers	.90	7.20	2,023.20	1,440.00
Lathers	.96	7.68	2,150.40	1,459.20
Plasterers	1.77	14.00	3,570.00	2,380.00
Cement Finishers	.80	6.40	1,798.40	1,126.40
Painters	.80	6.40	1,632.00	1,164.80
Plumbers	.90	7.20	1,965.60	1,440.00
Roofers	.65	5.20	1,461.00	884.00
Sheet-metal Workers	.90	7.20	2,016.00	1,332.00
Steam Fitters	.90	7.20	2,023.20	1,296.00
Stone Cutters	1.00	8.00	2,240.00	1,440.00
Tile Setters	1.00	8.00	2,256.00	1,660.00

The table is based on the average number of days worked during the year 1920 but this average will be probably somewhat higher during 1922 due to the abnormal amount of building being done and the favorable weather to date (Dec. 26). The hourly rate is that of union men; in cases where non-union men are employed the hourly rate may run higher or lower than the figures here given. These figures do not include any bonus which if given varies with each employer.

In only 4 out of the 15 trades considered do the theoretic annual earnings fall below $2,000 and in only one do they fall below $1,600. On the other hand the average annual earnings in only one trade rise to $2,000; and in only two other instances do they reach $1,800; in nine trades they are below $1,500.

As stated in the *Monthly Labor Review* in its conclusion, "The difference between the theoretic and the average annual earnings lends force to Secretary Hoover's statement that in the building trades 'one of the reasons for the constant drive for higher hourly wages is to maintain an adequate annual income and to offset the loss due to intermittent occupation.'" Probably also, it throws some light on the reasons for the fact, deplored by Senator Calder, that "American-born young men are no longer entering apprenticeships and learning construction trades from the bottom up, with a view to spending their lives in such work."

Storm King—A Modern Road Built Under Pioneer Conditions

Four-Mile Stretch Along Hudson Combines Scenic Beauty With Extreme Importance as Link on a Heavily Traveled State Route—Construction Difficulties Tax Contractors' Resource

LOCATION and construction difficulties which are to be expected in mountainous country in the West, when lack of transportation facilities combine with natural topographic obstacles to make new highway locations more or less inaccessible, appear entirely out of place in New York State where dense population, a network of improved highways and railways, and river transportation would seem to make a myth of inaccessibility. Yet, in the construction of the Storm King Highway, a route opened to the traveling public last November, were found all those natural difficulties which taxed the ingenuity and resource of the engineers who surveyed and designed, and of the contractor who figured and executed. The Storm King Highway job, therefore, may be characterized as a Rocky Mountain pioneer road project executed within 50 miles of the country's largest city.

FIG. 1—ROAD SKIRTING STORM KING FACE 400 FT. ABOVE THE HUDSON RIVER
Breakneck Mountain is seen on the opposite side of the river. The road at this point is almost directly over West Shore R.R.

Two features of the project are outstanding: The importance of the 4-mile link as part of a great transportation system; and the extreme difficulties met in locating and building the highway. The scenic beauties opened by the road are many, but to the technician acquainted with the history of the route's design and construction, even these are obscured.

History of Highway—Active effort to secure the construction of what is now designated as State Route 3 dates back almost 20 years. It was in 1903 that the first appropriation was made and preliminary surveys were begun. The original design called for a limiting 5 per cent grade and some tunneling. Upon this location designs were made and a bid taken and an actual contract was let for the work at a cost of $187,000, but before work had started a group of men got hold of land which was to be used as right-of-way and successfully held up the job by holding out for high prices.

Pending a final decision of right-of-way matters, temporary adjustments were made and a new survey taken. This time the design called for a maximum 7 per cent grade and the elimination of tunneling. This threw the location farther away from the river and about 400 ft. above it. When bids were again opened the lowest was $197,000 for building only 1.27 miles. In order to bring the cost within the appropriations a redesign was made in which considerable expense was eliminated by substituting a fill for a steel viaduct across the Big Gully. On July 26, 1915, the contract was awarded to the John L. Hayes Co., Yonkers, for $273,736.70.

By the time the war stopped construction a good deal of the road had been built, $264,000 having been expended. However, costs had mounted so high that it was necessary for a separate contract to be made, though, however, with the same contractor who began the work. Final estimates show that the cost of the completed highway is between two and three times the original engineers' estimate, though the discrepancy is easily accounted for when it is considered the estimate was made with pre-war construction costs existing and with no exact knowledge of terrain to be encountered possible.

Physical Features—The highway itself, 4.03 miles in

length, starts at Bayview Ave., Cornwall, climbing gradually along the side of Storm King mountain at about a 5 per cent grade until it is almost 400 ft. above the Hudson at the nose of the mountain. Then there is a descent of about 200 ft. on a 7 per cent grade back into the cove, across the Big Gully, and on around Crows Nest mountain to the West Point Reservation line. Thence it follows the base of the mountain, partly on new location and partly along the old Washington Valley road to its intersection with the state highway two miles west of Highland Falls.

The finished road is 24 ft. wide with 18 ft. of metaling for the greater part of its length, the highway having a bituminous penetration surface. In general the highway as a link in a north-and-south state route.

Importance as Traffic Link—There is a great deal of truck traffic which originates in the Newburgh territory and this, added to trucking and passenger traffic coming from points farther north, makes the traffic over a north-and-south route considerable. Until the completion of the Storm King road most of this traffic had to take a route traveled by vehicles coming from Binghamton over the state route which may be described as an east-and-west line. All the traffic, therefore, of the Binghamton and Newburgh territories came together at Harriman, Suffern, or Highland Falls, congesting the main route leading from those points to points in New Jersey and to New York City.

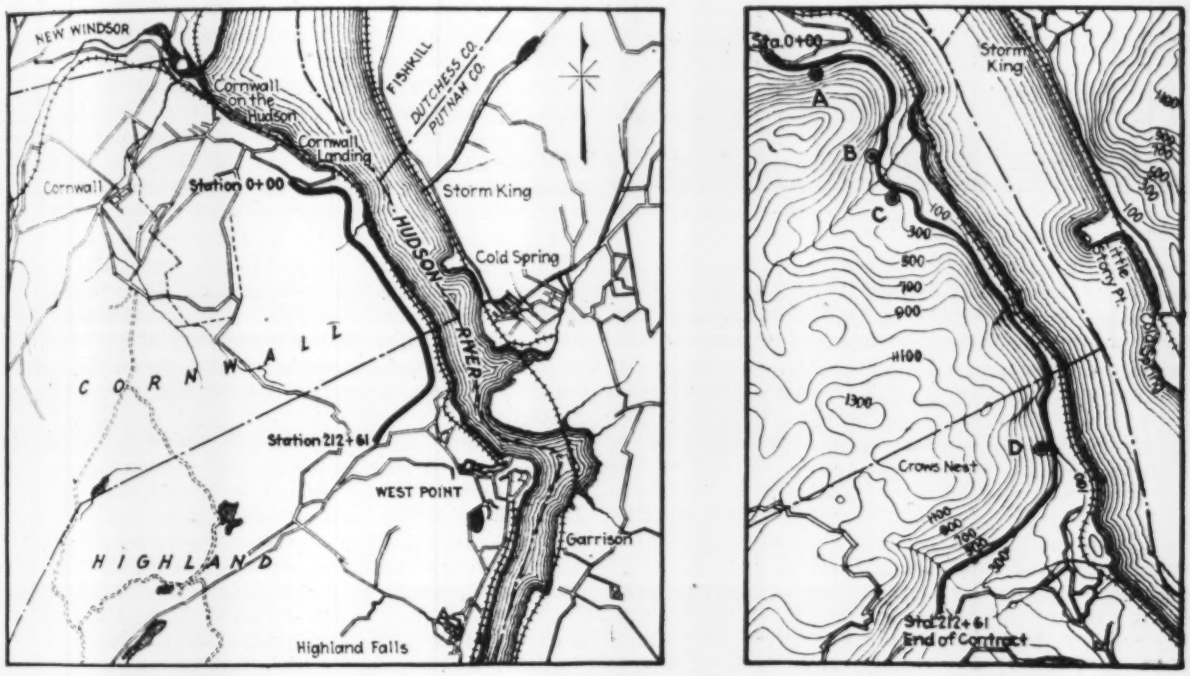


FIG. 2—GEOGRAPHICAL LOCATION OF ROAD AND TOPOGRAPHIC CHARACTER OF ROUTE TRAVERSED
A, B, C, D indicate points at which construction began. Manner in which material was got to these points is explained in text.

the cross-section is a sidehill section partly cut in solid rock and partly held in retaining wall construction. The heaviest depth of rock cut is over 130 ft. and the highest section of retaining wall 38 ft. The wall is surmounted by a rough stone parapet. Walls are dry masonry walls whose footings at least to the ground line rest either on solid rock or firm ground, and are set with masonry. In most cases beyond the ground line or above the wall footing the walls are of dry rubble.

One heavy fill was encountered at about Sta. 63+40 to 65+60 (the zero end of the contract was at the Cornwall end). This fill has an average width at the top of 26 ft., an average width at the bottom of 150 ft., and an average height of 90 ft. and crosses what is known as the Big Gully. Altogether, about 46,000 cu.yd. of material were placed in this fill.

The total rock excavation for the whole road amounted to 112,082 cu.yd., and the total earth excavation, 149,363 cu.yd. There are 25,746 cu.yd. of stone in masonry walls.

Before going into any of the design or construction features it may be well to explain the importance of

The use of Storm King, therefore, will divert the heavy truck traffic originating around Newburgh from this main east-and-west state route, relieving the congestion greatly. It will also make inter-communication between Orange County points, such as Monroe, Harriman, Highland Falls, and West Point, much easier and will enable traffic going from Cornwall to West Point, or vice versa, to cut off about 15 miles. The distance between Highland Falls, West Point, and Newburgh will be shortened about 18 miles and that between Newburgh and New York City about 15 miles.

Location—The final location was not possible because of unforeseen difficulties encountered in the construction work. However, the almost exact location was made, though around the nose of Storm King and at one or two other short points the location of the road in the field was impossible because of the precipitous slopes and the impossibility of doing any instrumental work. At such points the stationing was figured and topography taken by triangulating from the West Shore R.R. tracks below

Manner of Construction Attack—In attacking the construction work the contractor was practically con-

FIG. 3—SOME OF THE DRY MASONRY RETAINING WALL

fronted with a pioneer job. The zero end was accessible from an existing road, so that it was possible to start excavation work at about Sta. 19 with a full revolving crane which was utilized primarily for mucking and for laying masonry wall. This first point of attack is designated Point A in Fig. 2. An old wood road which had been used to get timber down from the height above West Point was utilized for hauling equipment to Point B. A revolving crane was sent in over this wood road and the haul was about 12 miles, the last several miles of which were such difficult going that blocks and tackles had to be utilized in pulling the crane upgrade and letting it down.

Point B was on the northern side of the Big Gully and the third point of attack, Point C, on the opposite side. It was impossible to cross the gully with equipment, so Point C was reached from below. An old road led from the river up the side of the mountain for several hundred feet and over this were taken small pieces of equipment, the steel parts of a traveling derrick, and finally a steam shovel. These were hauled from a spur track of the West Shore R.R. and block and tackle was also utilized, particularly when the steam shovel practically pulled itself up the mountainside. Mules also were used in getting equipment up the mountainside.

At Point D practically the same method was used in getting equipment up from the West Shore tracks as was used at Point C, though the haul was considerably less. At Point D was installed a bull-wheel derrick, the framing timbers of which were cut from trees on the job. Blacksmith shops were installed at all four construction points.

Construction Procedure—The usual procedure in construction work was to locate footing foundations for masonry walls first. When the footing excavation had been done, if any was necessary, and the wall carried up a sufficient height, blasting was done along the inside of the cut. It was often necessary to fire at least three lifts of holes before anywhere near approximate finish grade was reached. In many instances it was necessary to lash both drillers and drills to the rock in order to save either should the other slip.

Other pioneer features of the road construction work included methods used in getting the first bags of cement to various points on the job for laying masonry wall footings. At the beginning of the work cement had to be packed by hand in half-bag lots.

Compressed air for the entire job except the operation of one steam shovel was supplied from a line extending from near Cornwall through about 27,000 lin.ft. of 4-in. pipe. The impossibility of getting fuel to the site and the danger from using steam equipment on such a job made the use of compressed air a necessity.

One of the features of the job which indicated the finesse possible under such adverse circumstances was the facility with which rock shooting was accomplished. Particularly at the nose of Storm King and at Crows Nest, where the road almost hung above the West Shore R.R. tracks, it was necessary to avoid, in so far as possible, rock being hurled to the tracks below. Therefore, the contractor conceived the idea of drilling a line of holes fairly close together on the inside of the cut, then a second line a little farther out on the face, though considerably farther apart. At times a third line of holes, though widely separated, was drilled for the same lift. With these lines of holes drilled there was usually an undrilled ledge on the outside of the cut. When these holes were fired the resistance to the blast was in such a direction that the blasted material

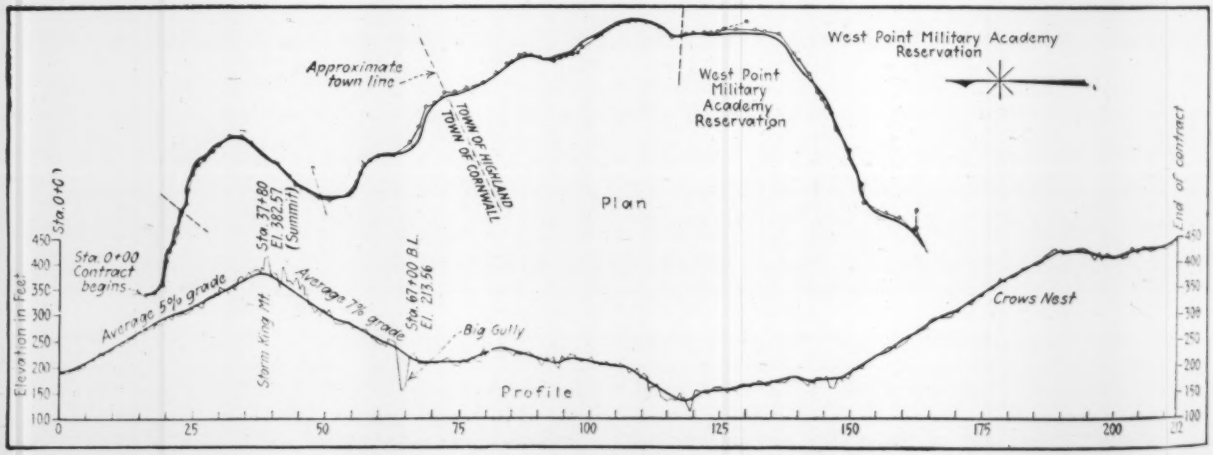


FIG. 4—PLAN AND PROFILE OF STORM KING HIGHWAY

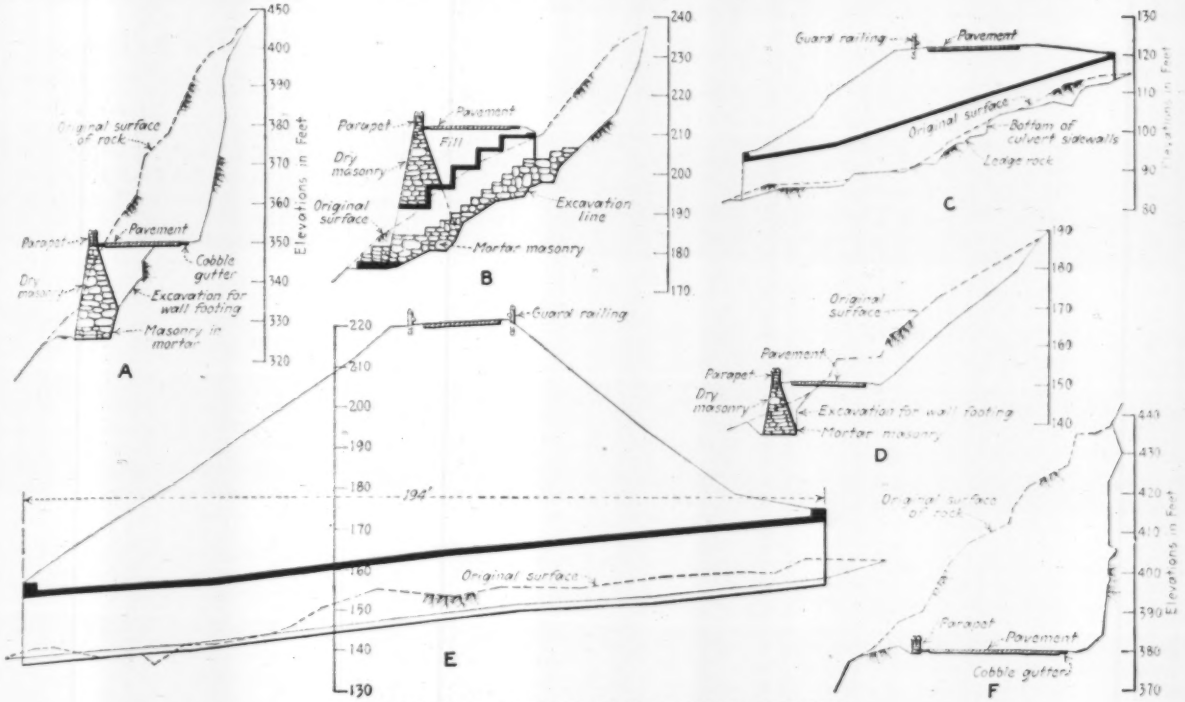


FIG. 5—TYPICAL CONSTRUCTION SECTION DETAILS

A—Section as constructed in ledge rock, typical for about 800 ft.
B—Culvert section through retaining wall on steep slope.
C—Culvert section as constructed on Storm King Mountain.
D—Section as constructed in earth and loose rock.
E—Section of the fill at Big Gully.
F—Section as constructed in ledge rock at the summit of roadway on nose of Storm King Mountain.

was thrown not directly toward the tracks, but in a line parallel with the axis of the highway. It was impossible, of course, to keep some rock from going over, but after this system had been followed and experience had taught them what could be done the powder men could throw the spoil in a place where it would do the least damage to the railroad tracks.

Another interesting feature in the work was the care with which the work was prosecuted to avoid any great amount of damage to railroad tracks or to rolling stock. When blasting along the nose of Storm King, operations were practically controlled by the dispatcher at Jersey City. It was he who, through telegraphic communication to the contractor's representative at Storm King, let it be known when trains were to pass, after which blasting could be done and the tracks cleared immediately for succeeding trains. The efficiency of such a system is easily seen when it is known that not a single train was damaged.

A special clause in the contract gave the contractor a higher classification for rock blasted where there was direct danger of injuring railroad tracks or equipment. There were two such areas—known as crane areas—below the nose of Storm King and at Crows Nest. Within these crane areas it was necessary to keep gangs of men and equipment to clear tracks after blasts. A lump sum was also included in the contract to cover such overhead. At Storm King, where the highway is about 400 ft. above the railroad and almost directly over it railroad ground wires were protected by a boxing of 3-in. plank. Ground wires were further protected by being inclosed in a heavy cable, but even with such heavy protection frequently boulders would fall smashing the boxing and at times cutting the cable. The highway is only about 200 ft. above the railroad at Crows Nest so the danger of injury to railroad structures was minimized at that point.

Though a final paper location of the road was made prior to beginning construction work, when construction work was actually carried out it was necessary to revise the location according to terrain conditions encountered. For instance, it was necessary quite frequently to drop masonry wall footings several feet lower or pull them in considerably toward the cliff from positions noted on the paper location, making additional cut and therefore additional cost necessary. In other words, the job was one in which final design and construction were carried on simultaneously. In excavating for masonry wall footings it was usually necessary to take out several feet of ledge rock because of seams, disintegrated pockets and sloping faces. Only occasionally did anchor bolts have to be used between foundation and bottom course stones.

About a dozen water courses were encountered along the four-mile section and culverts for these had to be designed so that water would be delivered at the outside of the road in such a fashion as not to endanger wall footings. The bottom and sides of such culverts usually were made of mortar masonry and set to follow practically the original ground line. The tops of culverts were usually of concrete. A typical section is shown in Fig. 6.

The first construction work was begun in 1915 when Edwin A. Duffy was state highway commissioner, and under the direct supervision of Bert Wait, then division engineer, Division No. 1. It was completed under James H. Sturdevant, divison engineer of Division 1, with E. J. Howe, resident engineer in charge of construction. Herbert S. Sisson is state highway commissioner.

Does Highway Engineering Call for Locating Skill?

A Sheaf of Answers to the Questions Raised in *Engineering News-Record* of Nov. 9 by R. S. Blinn, Who Charges Much Poor Highway Location to a Lack of Railroad Training

IN THE issue of Engineering News-Record *for Nov. 9, 1922, p. 808, R. S. Blinn raised two questions: Is railroad locating a lost art? Does highway engineering suffer from the lack of engineers trained in railroad location? On page 775 of the same issue we commented editorially on these and suggested that some of the older locating engineers and the younger highway engineers might be able to shed more light upon the subject. The following extracts are from letters that have since reached us.*—EDITOR.

F. M. Hill

State Highway Department of Georgia

IN THE MORE SETTLED communities the location of highways often requires more of diplomatic than of engineering technique, a quality in which the "old timers" were not always proficient. There remains, however, a vast amount of highway work to be done in the broken and undeveloped regions, where locations can still be made along strictly engineering lines, and it is here that the question raised by Mr. Blinn becomes of outstanding importance.

Answering the question raised in your editorial "Just how great is the need, in highway engineering, for locating skill?" I have no hesitancy in saying that in mountain work at least, it is fully as great as in railroad work. It is well to remember that many highways now being constructed, and many more which will be undertaken within the next few years, involve an expense for grading and drainage structures greater than that of many railroads; and justice to the taxpayers who are furnishing the funds for this construction demands that we spare no pains to secure the best "locating skill" available.

There is unfortunately a large share of highway construction in every state which cannot be located on a strictly engineering basis—where we must stick to the old road or not build. But even here a thorough knowledge of location is not out of place.

One difficulty in securing the best talent for location arises from the fact that we are obliged to make these locations piecemeal, locating just enough of the road to use up the appropriation that is available, and for this work it often happens that the only man available is one who has not had the training or experience that the job really requires. Yet we must use him because the job will be of such short duration that we cannot make it attractive to a man of real locating ability.

If a state having much of this work in prospect could so arrange its budget as to enable it to keep a locating party continuously in the field until all the surveys have been made, more attention could be paid to securing the proper man, and he in turn would have more time to develop his location.

* * *

R. Z. Myers

Assistant Division Engineer, State of Ohio, Division of Highways, Chillicothe, Ohio

GENERALLY SPEAKING, railroad location and highway location as sciences cannot be compared, from the mere fact that most of the factors involved in the former cannot be considered in the latter, and vice versa. For example, in locating a highway line the locator is not restricted in the matter of maximum grades and curvature to the extent that he would be if he were locating a railroad. The problems of the highway locator involving curvature and grade are a series of local problems each of which may be solved on the spot separately as the location progresses, whereas the railroad locator may have the problem of locating a line with two or more controlling points such as a mountain pass, a desirable river crossing, a town or city, or an existing main line of the railroad company, all of which may be far apart and all of which are to be connected with the most economical line possible within the limits of grade and curvature.

On the other hand, the highway locator is limited in many instances to the simple problem of laying his line over an old traveled road or conforming to certain well defined property lines in which case his "located line" is nothing more than a base line upon which the actual construction of the road is referred. The writer does not desire to leave the impression that highway location is unimportant from an engineering and economic standpoint but rather to call attention to the more flexible nature of the factors that enter into highway location as compared with those of the railroad.

Our old-time railroad locator usually was sent out by the railroad company to locate a line, which he did to the best of his ability and engineering judgment, being responsible only to the company employing him. If he met with any opposition from a property owner or otherwise, the company fought this battle itself by condemning the right-of-way over the disputed land. The highway locator, however, is confronted with a different problem; he is serving the public and trying to please not one party but many individuals, automobile clubs and other organizations all of whom may be vitally interested in the project financially or otherwise. Our highway locator here has a problem with which he must use much diplomacy and in some instances, it is regretted to say, he must subordinate his engineering judgment to stronger influences not in any way connected with the science of engineering.

* * *

W. G. Caldwell

County Highway Engineer, Waukesha Co., Wis.

THE PURPOSE of the railroad is to furnish transportation between two points. The purpose of the highway is to furnish the means for transportation between two points and between all intermediate points.

The determining points for the location of a line of railroad are cities five, ten or twenty miles apart or more. The determining points for a highway are generally: farm buildings, orchards, existing roads, cross roads, and section lines—a quarter of a mile apart or less.

The construction of a railroad is financed by men directly interested in the cost of operation. The construction of a highway is financed by men vitally interested in the cost of construction but only remotely interested in operation.

The differences in these three points alone show why a knowledge of railroad location might be handy but is not necessary to the average highway engineer.

* * *

Fred Lavis

Consulting Engineer, New York

THE TECHNIQUE of surveys for highway location and the actual layout of the location, can undoubtedly be benefited by a study of the methods of railroad location. The fundamental principles underlying highway location are, however, different from those governing the location of railways, even if the highways are to be built through virgin territory unhampered by the need of following an existing road.

These principles are, however, different only in detail. There is a different minimum radius of curvature, the rates of gradient may be as high as 10 or 12 per cent, instead of 2 or 3 per cent, rise and fall may not have the same value, and the operating economics of horse-drawn vehicles and motor trucks are not well understood, but these are only

matters of detail. A man accustomed to railroad location will, I am sure, be a better man to locate a highway, provided, of course, he has sense enough to realize the differences and their significance.

Mr. Blinn need not worry much, because highway engineers rediscover old methods, this is not uncommon and does no harm; there always must be a certain amount of lost motion. Neither is there cause to worry about the locating engineers dying off; there are still quite a few left and as the world gets straightened out and recovers from the effects of the war, there will be many, many more miles of railroad built in South America, Asia and Africa, which are as yet almost untouched.

The one thing that may militate against the further development of good locating engineers for railroads is the fact that much of the railroad construction of the future is almost sure to be under government auspices, thus minimizing the impelling need of "making a dollar earn the most interest." This is also the case with highways. Without doubt a knowledge of the principles of railroad location will help in the proper location of highways, but also without a doubt many highways and railways will be located and built without regard to true economic principles.

* * *

F. R. Quackenbush

Formerly Highway Engineer, U. S. Bureau of Public Roads, Washington, D. C.

JUST HOW GREAT is the need in highway engineering for locating skill? In thickly populated districts practically all road improvement follows the old roads. Therefore, locating skill is of minor importance. In sparsely settled territory where new roads are to be constructed locating skill is of prime importance. The first-class highway engineer must know what curves and rates of grade are permissible, what relation the road to be located bears to connecting highways, what type of road is to be constructed, approximately how much money will be available for construction, the source of materials for construction, the kind of soil conditions that are most favorable, what rock is to be encountered. These and various other factors control the locating of a new highway and it is my candid opinion that unless a man has been through the mill as a highway designer and highway builder he may fall down on the job regardless of other experience. I will grant, however, that a railroad locator who takes all necessary points into consideration will be likely to do a better job than a man who has not had such experience.

What share of our highways can be located as a railroad would be, and what share must stick closely to existing roads? The U. S. Bureau of Public Roads should be able to give a fairly definite answer to this question. I would risk a guess that less than 5 per cent of the mileage of hard surface roads in the United States could have been located in the same manner that a railroad would be at the time they were surfaced. Most new roads follow some old trail at least and there are so many influencing conditions, that railroad practice can seldom be followed.

To what extent is the location, even of new highways, controlled by conditions outside the domain of engineering science? This query is not intended as a joke, but I am tempted to give the answer in three words, *mostly by politicians!* Seriously, there are many things outside the engineering domain which belong inside this is one of them.

And even though there may be room for a science or an art of highway location, to what extent would this agree with railroad practice and to what extent must wholly new or modified principles be developed? The old railroad lines were nearly all built as large units for certain definite purposes and could be located to make other things conform to them. Highways are coming long after railroads and many other improvements. They are built in small sections and must conform to what has preceded them. To my mind, here is one fundamental reason at least why railroad practice and highway practice must necessarily differ. Railroads carry heavy loads in large units and must have easy curves and slight grades. Roads carry quite heavy loads to be sure, but in small units and the vehicles can make quite sharp curves and steep grades, if necessary. In railroad work exact balancing of quantities of cut and fill is not necessary. In highway work, as a general rule, earthwork quantities should be more carefully balanced. If this is not done the reason should always be stated in the plans. The principal drainage problems of railroad men, because of heavy work, is to build waterways. The principal drainage problem of highway engineers is properly to drain the subsoil under and near the road. I could go on and name several other items that vary between the two fields, all of which have a direct bearing on location. My answer to this question is that it is necessary to have almost an entirely different set of principles.

* * *

H. J. Tinsley

Bent, N. M.

R. S. BLINN states a truth, applicable to at least a portion of the states, when he speaks of too little money being spent on location and too much on office calculations. He makes some other statements, however, that are misleading and wide of the point. He says, "all the methods of locating railroads are applicable at the outset in locating highways."

The transitman, levelman and topographer on highway location each may employ the methods of his railroad brother in instrument work for they are the same. The problems of topography, as they confront the locator, are the same but he is working in a much more flexible field than the railroad locator and has a greater latitude in which to satisfy alignment and profile.

Mr. Blinn is of the opinion that a man must be practiced in railroad location before he is qualified to locate highways From a study of my own work and from inspection of the work of other railroad locators, working in the highway field, I am convinced that a good railroad locator starts as a poor highway locator and he will continue to be a poor highway locator just so long as he attempts to use railroad methods in his work. For the railroad man, accustomed to picking a line meeting the narrow limitations imposed by heavy engines and long trains running on steel rails, it requires a sharp revision of methods to get him away from the long tangents, flat curves and smooth profile so essential to the railroad but of minor importance to the highway. A grade line carrying adjoining summit and sag verticals makes an easy riding profile for an automobile and goes a long way in reducing excavation quantities, but it could not be used on a railroad.

And again, about 75 per cent of the highway locator's work is confined to following old alignment of present roads where about all that he can do is to "shoot her up the center" with an occasional curve or grade improvement.

Far be it from me to belittle the province of the highway locator. I contend that he should be the most experienced man in a state's highway organization, and that he should have charge and supervision of all location work in the state, for is not the *location* the one and only permanent feature that an engineer can bequeath to any structure?

* * *

R. D. Rader

District Engineer, Montana Highway Commission

AS ONE of the "newly-born highway engineers" who has been locating highways for ten years in mountain country—and this without first locating a railroad—I wish to take issue with Mr. Blinn on his statement that "unless the highway locator assimilates these principles through actual practice in railroad locating, we will continue to have poor highway locations." An excellent highway location may be very poor railroad location, and vice versa. A railroad locator is prone to long line and grade tangents which are expensive and useless on mountain highways. He is apt to forget that a rolling grade with a 5 per cent or 6 per cent maximum is just as satisfactory and much more economical than long sustained grades. Many of our highway engineers were previously railroad location and construction engineers, but these men all have had to modify the principles and methods learned in railroad work very considerably in order to fit them to highway conditions.

I agree heartily with Mr. Blinn in the importance of careful location of mountain highways. The cost of a careful location by an experienced man will be saved many times over, not only in construction costs, but in maintenance cost and the cost of operating vehicles. No highway should be constructed until all possible routes have been investigated, and it is certain that the best location has been secured. And the securing of the "best location" involves so complicated adjustment of the usually conflicting demands of alignment, grade, first cost, probable maintenance cost, local traffic needs, long distance or through traffic requirements, freedom from snowdrifts, drainage necessities, scenic values, and many other considerations; that often "old time locators" do not agree on details.

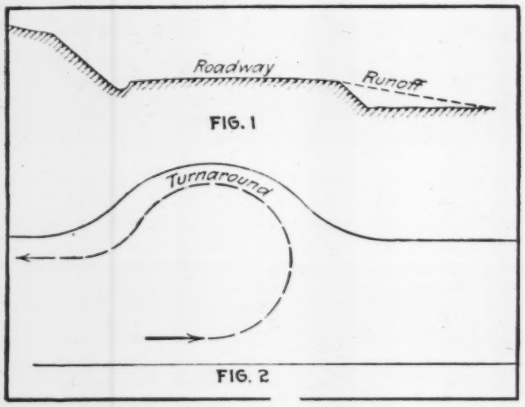
* * *

M. J. Patterson

Denver, Colo.

WE ARE BUILDING many fine earth and gravel roads in our mountains, which I would only criticize as following too closely the railway engineers' ideas, without due regard to the differing requirements of the automobile tourist.. The roads are mainly through national forests, where the location is unrestricted, and are largely intended to make such forests accessible to automobile tourists and campers.

I can explain my criticism most clearly by use of special examples. Last year I came East on the fine road over Monarch Pass connecting the Gunnison and Arkansas



RUNOFFS AND TURNAROUNDS FOR HIGHWAYS

valleys. I desired to camp before reaching any great altitude, but the road is as shown in cross section by full line in Fig. 1. I passed many attractive spots which I could not utilize, as there was no way to get off the road and back on again. A few "runoffs" as indicated by dotted line in the figure would remedy this.

A second illustration is afforded by the fine road up Bear Creek Canyon. The need here is for convenient places to turn or to get out of the traffic while making adjustments. I have often run several miles further than I desired on this road for lack of a convenient place to turn, especially when the road is muddy and the few flat spots beside the road are too slippery for traction. A few "runoffs" as shown in Fig. 1 or "turnarounds as indicated in Fig. 2 would remedy this. A railway train runs from town to town, but an automobilist often desires to turn back between towns.

Another regrettable tendency shown is that of making too long continuous grades. On some of the more popular mountain roads thousands of cars pass in a day. A considerable number of them need to stop for minor repairs or adjustments. Some adjustments can not be made with locked brakes and resort is had to blocking the wheels with stones while the adjustment is made. It is of course reprehensible to go off and leave the stones there, but it is often difficult to start and hold the car on the grade, while getting out and removing the stone. Preferably there should be level spots every half mile or so and a widened roadway at such spots when practicable. Such criticism as is implied in the above, is that the highways are too often designed for through continuous travel.

Another kind of problem occurs in many cases, of which our Berthoud Pass road affords a typical example. Here the road follows a rather easy grade up Clear Creek and North Clear Creek, then makes an abrupt climb to the top of Berthoud Pass and an equally abrupt descent to the Fraser River. On the original road the final climb and the descent were each about four miles long. I judge the average grade was about 15 per cent with some steep pitches running up to probably 25 per cent. This road was also very narrow and the surface rough. Automobiles of fair power climbed it readily but many cars in poor condition failed on the steep pitches.

On the relocated road the grade is reduced to 6 per cent and the climb is lengthened from four miles to about ten miles, with much increase in curvature.

I doubt the desirability of so great a change. The road would suit me better if it had been widened, surfaced, and evened out to a 15 per cent maximum grade without increase in length. On mountain roads the speed attainable is usually limited by the visibility of the road ahead, and owing to obstruction of view by curves one cannot safely make much more speed on a 6 per cent grade than upon a 15 per cent. Probably truck owners will prefer the lighter grade. And perhaps mile for mile the 6 per cent grade is easier to maintain.

But all of our mountain roads have to be resurfaced after a rain, particularly if traversed by trucks while wet, and it would seem probably cheaper to drag four miles of road than ten. Also it seems undesirable to encourage by easy grades the use of trucks on roads so readily destroyed.

The question of the best grade to use in getting from one point to another near by, but much above, will probably remain a matter of personal opinion. A pedestrian usually takes the short but steep path. His method of locomotion is adapted to climbing. A locomotive goes the long way around. It is not adapted for steep climbing, but with a reasonable certainty of a clear track, it can make up by speed for a considerable increase in distance. An automobile is rather intermediate between the two. It cannot climb precipices, but by reason of its change gear it can readily climb considerable grades. It also is never sure of a clear track around curves. Personally I believe that 15 per cent grades are preferable to 6 per cent in many cases where the distance is necessarily inversely as the grade.

I might say that the old grade over Berthoud carried all the traffic (by teams) from Denver into Middle Park for many years before the railroad was built, and I doubt whether even the old teamsters would prefer the new grade with a distance increased from eight miles to twenty. Outside of the mountain district there are some cases where I think highways would have been improved by following railroad practice. I refer particularly to concrete main roads where I think the curves should have been banked and perhaps spiralized.

* * *

Edward Gillette

Sheridan, Wyo.

MINIMUM GRADES and the elimination of grades or hills seem to be as important on highways as on railroads, for the lifting of loads requires corresponding power, and as the speed is not so different a little extra distance is nothing compared to lifting a load over a hill. Highways are blocked by snow in shallow cuts just as the railroads are. It is painful to see a well-built concrete road following curves for which there is no excuse, or to see a road forced to follow the bluffs on the side of a valley when a line through the middle of the valley would enhance the value of the good land two or threefold and at the same time make a road cheaper to construct and maintain, effect a saving in transportation of all kinds and insure greater safety in travel. In our headlong rush to spend money on highways this question of proper location seems to have been pushed one side and no doubt considerable of our highway location ultimately will have to be abandoned. The cost to increased traffic in the future will be too great.

Continuous Frame Design Used for Concrete Highway Bridges

Flat-Arch Types Over Bronx Parkway Roads Have Reinforced-Concrete Frame With Cut Stone Facing—Save Money

By Arthur G. Hayden

Senior Assistant Engineer in Charge of Design, Bronx Parkway Commission, Bronxville, N. Y.

Clearance conditions and architectural demands in the roadway crossings of the new Bronx River Parkway north of New York City have led to the adoption of a special type of continuous-frame reinforced-concrete bridge which presents some novelty in design and economy in construction. One of these structures carries Swain St. over the Parkway Drive and accommodates a roadway 32 ft. wide and two sidewalks each 10 ft. wide. The other carries Palmer Ave. over the drive and accommodates a roadway 30 ft. wide and two sidewalks each 8½ ft. wide. The clear span of both structures over the drive is about 42 ft.; overhead clearances at the center of drive 15 ft. and at the curbs 11 feet.

The grades of the streets and of the Parkway Drive and desired clearances together with architectural requirements precluded beam construction and limited the design to an arch-like structure with but 12 in. crown thickness. On account of the relatively great height over the curbs at the sides of the driveway, a true arch design would have involved abutments with excavation and compacting of roadway fill whose cost would have been disproportionate to the function performed by the arch proper. This consideration led to studies of the type of structure shown in the accompanying figures which is nothing more than a reinforced-concrete frame to sustain lateral earth pressures as well as the vertical loads which it is designed to carry. The economy in concrete, excavation and compacting of roadway fill permitted by this type of design is considerable—the estimated saving in cost over a true arch design being about $5,000 for each structure.

The first studies were made for a structure with a permanent hinge at the crown, the hinge consisting of a vertical joint through the concrete for the full width of the bridge, the steel in the upper face running through (Fig. 3). The steel acting alone was sufficient to carry the thrust and the shear from unbalanced live-load but relatively very small bending moment. The bending action of the rods due to the passage of heavy live-loads was negligible. The appearance of a joint in the soffit was considered to be objectionable architecturally, however, and the design was discarded.

The design adopted is for a structure continuous at the crown as shown in Fig. 4. In such a structure, the bending moment at the crown (or any other section for that matter) is affected by the elastic properties of all other sections as well as by the magnitude of the vertical and lateral forces. Increasing the strength at the knees for example decreases the bending moment at the crown for any system of loads and vice versa. Increasing the strength at the crown increases the bending moment at the crown for any system of loads and vice versa.

Alternate Designs—Since there will be several other structures of this type built on the Parkway, most of them of about the same span length, two complete designs were made for the same loadings, to study the effect of varying the proportions at the knee. Design A (so called) had 4 ft. thickness across the knee and 12 in. crown thickness; Design B had 3 ft. thickness across the knee and 12 in. crown thickness. In Design A the maximum positive bending moment at the crown is 10,400 ft.-lb. per ft. width of structure. In Design B the bending moment at the crown *for the same loading* is 15,500 ft.-lb. or 50 per cent more. The corresponding negative bending moments at the knee are: Design A, 86,400 ft.-lb. per ft. width of structure and Design B, 74,400 foot-pounds.

Design B is the more economical and was adopted for Palmer Ave. and all future structures of the same span. Plans for the Swain St. structure were made before comparative designs, to determine economical proportions, but agree quite closely with Design A.

Design Conditions—The amount of passive earth pressure which will be developed as a result of compacting the roadway fill and by flexure of the frame under load is an undeterminable quantity and must be assumed. The following conditions were investigated:

(a) Dead-load, and balanced active earth pressure, with or without live-load.

(b) Dead-load, and balanced earth pressure equal to three times the active earth pressure, with and without live-load.

(c) Dead-load with lateral earth pressure on one side only.

(d) Dead-load without lateral earth pressure.

(e) Earth pressure alone equal to three times active earth pressure, representing conditions before removal of falsework and the action of dead-loads.

The live-loads assumed in design were a uniform load of 100 lb. per sq.ft. on any part of the roadway and sidewalks, or, three 20-ton motor trucks on 30 ft. width of roadway in addition to sidewalk loads.

Conditions (c) and (d) presumed that earth pressure might be removed from one side or both by future excavation for some purpose or other. Such conditions will never be realized, however, for provision has been made for carrying telephone ducts and gas and water pipes up to 8 in. diameter over the structures in the sidewalks, and future excavation back of the vertical wall-abutments will not be necessary. A calculated unit stress of 20,000 lb. per sq.in. in the steel at the top of the footing with unbalanced earth pressure (earth pressure on one side only) was therefore permitted. All other conditions were met without exceeding 16,000 lb. per sq.in. in the steel or 650 lb. per sq.in. in the concrete in any part of the structure.

This type of structure may be used for much greater span lengths than the Swain St. or Palmer Ave. structures and the crown-bending moments kept within proper limits by giving sufficient flexibility to the crown sections and sufficient rigidity to the knee sections. Calculations are being made for a span length of 55 ft. for another structure on the Parkway.

If the intrados is of sharp curvature, stirrups near the crown, where heavy bending moments exist, will constitute an important detail, although in a true arch they are more or less redundant. The crown section acts like a curved beam between points of contraflexure, and the curved lower tension rods will tend to straighten out and spall out the thin layer of concrete between the rods and the soffit. Stirrups will be required to secure these rods to the upper rods and pre-

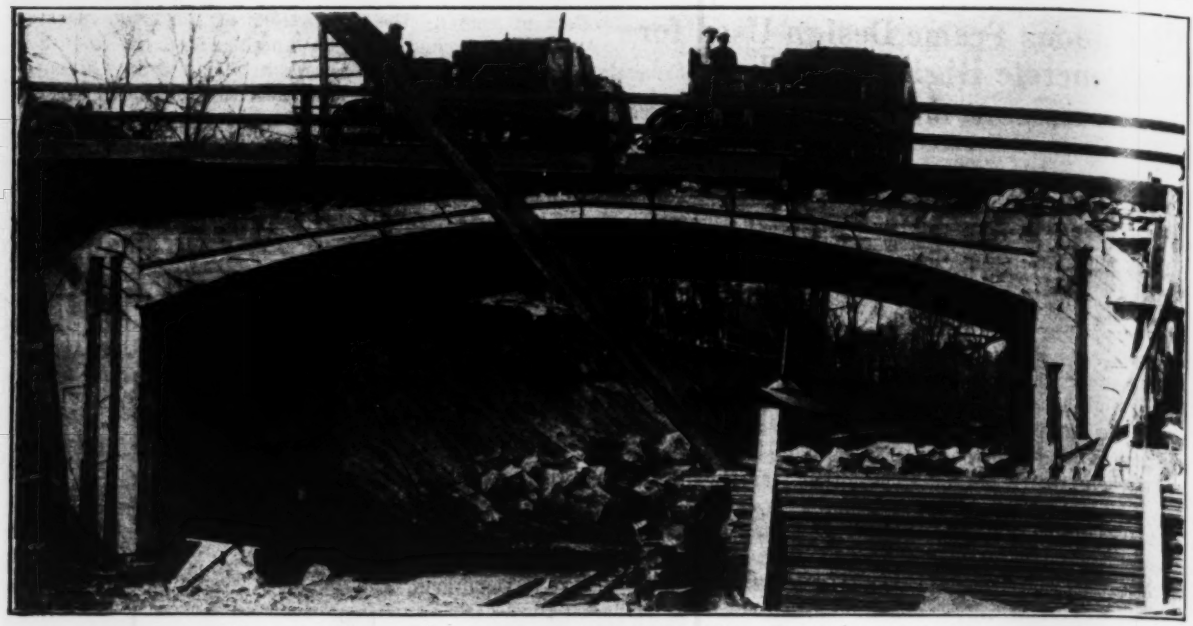


FIG. 1—SWAIN ST. BRIDGE IN BRONX PARKWAY NEAR NEW YORK CITY
A continuous-frame concrete structure, here shown before final stone facing and carrying 40-ton test load near the crown of first section (22 ft. wide) built. This bridge is much thicker in section than later ones of same type.

vent such action. They will furnish the required vertical components to the increments of direct stress.

Construction Details—One-half of the width of the Swain St. structure was built at a time. Traffic was maintained on the north side of Swain St. while the south side of the street was excavated, and the south half of the bridge built. Traffic was then diverted over the south half while the north half was built.

Each half of the structure was built in vertical sections, small enough to make a day's work of concreting for a small plant. The footings were first laid, with dowels projecting therefrom to which the main reinforcing rods in the vertical wall-abutments were to be spliced. All the remainder of the steel reinforcement was then placed on the forms. The excavation was made to lines sufficiently accurate to deposit concrete directly against the earth and dispense with the back forms. The second lift carried the concrete up to the bend of the knees and the third lift completed the top of the frame. Construction joints between the footings and the vertical walls and between the vertical walls and the top of the frame were made approximately normal to the line of direct stress and furnished with keys.

When the first half of the structure had been completed, the falsework was removed, although instruc-

FIG. 2—SWAIN ST. BRIDGE AFTER STONE FACING HAD BEEN PLACED

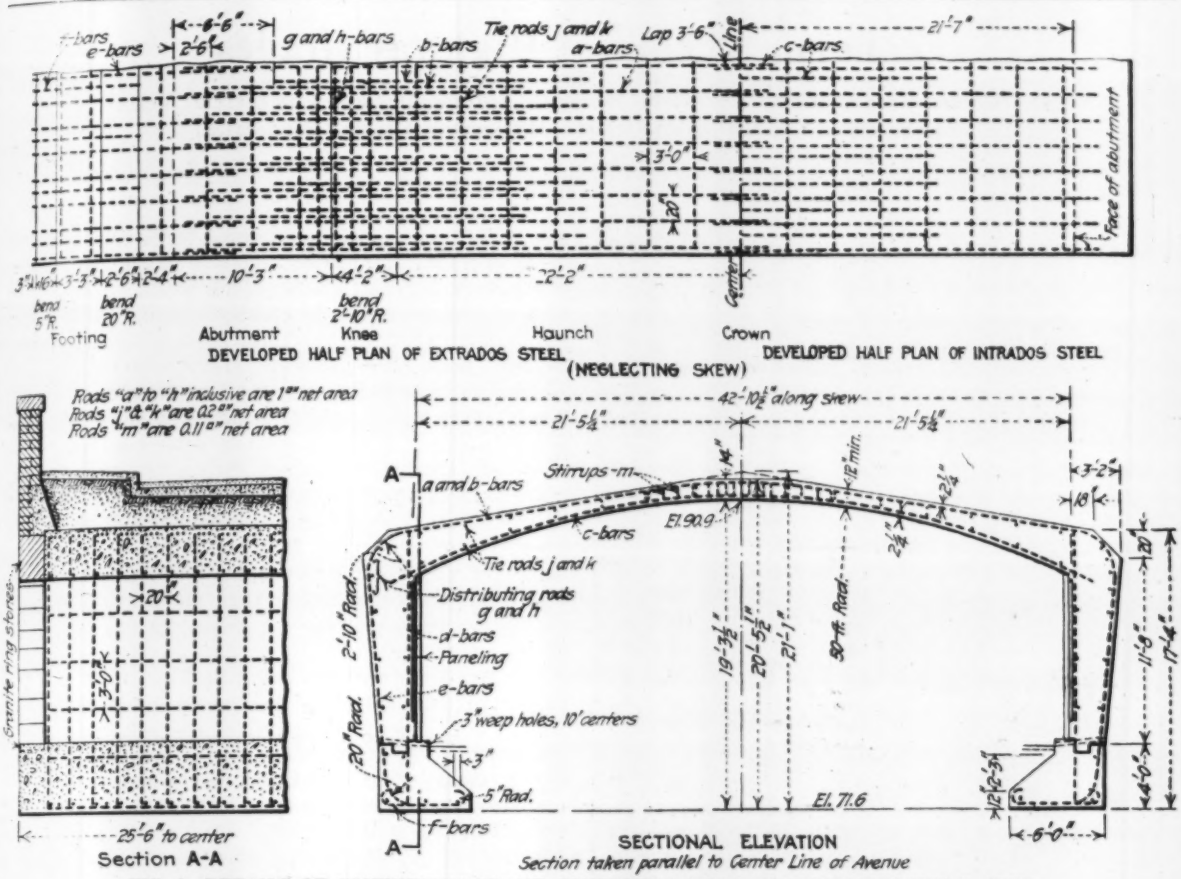


FIG. 4—DETAILS OF CONTINUOUS-FRAME CONCRETE BRIDGE OF BRONX PARKWAY TYPE

tions had been issued to the construction forces to leave it in place until the second half of the bridge had been completed and lower the falsework for the entire structure at once; the transverse reinforcement being designed as continuous for the full width of the bridge and no permanent joint between the two halves of the structure being provided, so that the differential deflection between the two halves could not be equalized. However, the dead load deflection of the first half was too small to be measured without delicate instruments and no trouble developed when the falsework for the second half was lowered.

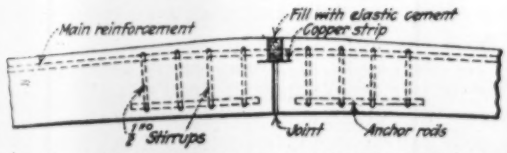


FIG. 3—DISCARDED DESIGN, PERMANENT CROWN HINGE

The width of the first section built was 22 ft. and ⅛ in. deflection noted for a 40-ton test load at the crown.

The Bronx River Parkway extends from Bronx Park, New York City, to Valhalla, Westchester County, New York, and is being developed by the Bronx Parkway Commission of the State of New York. Madison Grant, William W. Niles and Frank H. Bethell are the commissioners, Jay Downer, engineer and secretary and L. G. Holleran, deputy chief engineer. The design of these bridges was developed by the writer, with the assistance of D. P. Babcock and J. J. Carroll in carrying out the computations and details, and was reviewed as to general practicability and analysis of stresses by N. Casores under direction of Shortridge Hardesty of the firm of J. A. L. Waddell, consulting engineer. The architectural treatment of Swain St. bridge was developed by Charles W. Stoughton, architect, of New York City, and the result will be a very beautiful structure.

The Palmer Ave. and Swain St. structures are being built by the commission's construction force. L. A. M. Bushnell is in direct charge of the work under Gilmore D. Clarke, superintendent of construction.

Solid Wood Decks With Asphalt Surface on Chicago Bridges

A solid timber deck composed of planks alternately 2x6 and 2x4 in. set on edge so as to form a grooved surface and covered with a bituminous wearing surface has been in use on some Chicago bridges for three years, and was described in *Engineering News-Record*, Nov. 13, 1919, p. 866. According to Alexander Murdock, city engineer, and Thomas G. Pihlfeldt, bridge engineer, the results have been satisfactory where asphalt was used. But where the surfacing was of torpedo sand and coldpatch composition the pavement became so hard as to crack under traffic and jar out of the grooves. No trouble was experienced from flowing of the asphalt in hot weather, and the waterproof character of the pavement has been very noticeable, as indicated by keeping the steel under the floor clean and free of rust. Up to date the preferred pavement for bridges is of 4-in. creosoted blocks laid with 1x3-in. strips between the rows of blocks to form grooves and thus afford a good grip for horses. This block pavement is laid on 6-in. creosoted sub-plank.

Economic Theory of Highway Grades

Tests in Iowa Give Working Equations for Both Automobiles and Commercial Vehicles —Relation of Grades to Fuel Cost—Momentum Grades Economical

By T. R. Agg
Professor of Highway Engineering, Iowa State College, Ames, Iowa

INVESTIGATIONS to establish the fundamental theory of highway grades were started in 1919 at the Iowa Engineering Experiment Station and the work has continued until the present time. It now appears that a tentative theory of highway grades may be proposed, but several years' additional work will be required to evaluate all of the variables that enter into the problem. In 1920 the work at Ames was correlated with the program of highway research proposed by the Advisory Board on Highway Research of the National Research Council. By so doing the final conclusions will be reached more quickly than otherwise because a number of investigators are now working on some phase of the problem.

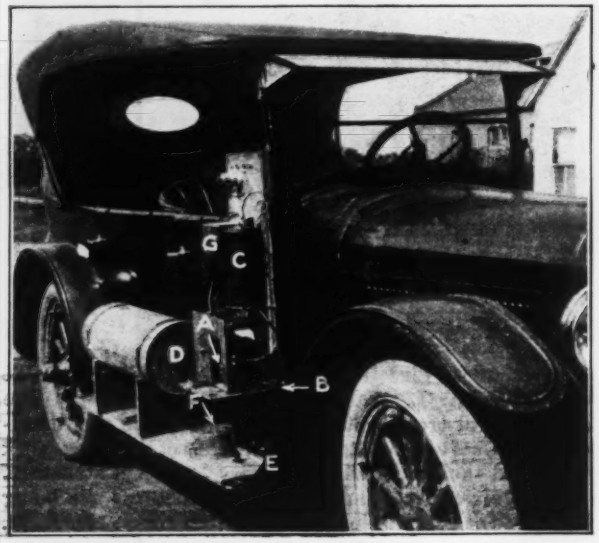


FIG. 1—FLOWMETER ATTACHED TO AUTOMOBILE
A is the diaphragm; B, the piezometer; C, an ordinary vacuum tank; D, an auxiliary gasoline tank; E, the speedometer cable that drives the paper rolls; F, the clock for indicating speed, and G the spark coil for furnishing the high tension recording spark.

The first attempts to measure the effect of highway grades on fuel consumption and speed were crude and yielded little real information. A few vehicles were equipped with calibrated tanks for gasoline and trips were made up hill and down again, the fuel consumed being carefully determined for each trip. The results of a few of these measurements of fuel consumption are shown in Table I. A little consideration of the data in that table will show that the indication is that any grade will result in greater fuel consumption than would be required for level roads. That is wholly incorrect as later investigations show, and the fallacy of the results of the measurements shown in Table I lies in the fact that the method employed does not take into account momentum effects that are always present when a vehicle is operated over hilly roads.

The next step was to secure a continuous record of rate of fuel consumption and speed while vehicles were being operated over various sections of highway among which were included grades of all kinds. The difficult part of the work was to secure a means of metering the gasoline as it was used, and much time was devoted to that particular problem. The instrument finally adopted is sufficiently accurate for the purpose of the investigation and is readily attached to any vehicle and fairly sturdy. Researches that have been conducted elsewhere show that rate of fuel consumption is not a direct measure of power delivered by the vehicle, due to characteristics of the throttle-governed, four-cycle, gasoline motor. In the Ames investigations fuel consumption was used to determine the effect of grades and while the comparisons thus made are not exact, they do serve to uncover the principles underlying the theory of grades.

The Ames flowmeter is shown in Fig. 1 and the form of record obtained from it is shown in Fig. 2. The instrument is so designed that the velocity head in the gasoline flowing to the motor is measured through the medium of a piezometer ring and a sensitive diaphragm. The instrument is calibrated on the vehicle upon which it is to be used. The record of variation of head of gasoline is punched on the paper by a high-tension spark. Vehicle speed is also recorded on the record paper by a spark. The calibration curve for the flowmeter is shown in Fig. 3.

After the instrument was calibrated the vehicle was operated over various sections of highway in a normal manner, there usually being five round trips in a series of runs. The flowmeter data was then platted on profile paper along with the road profile and the speed curve so that they could be studied. Fig. 4 shows the gasoline profiles for five runs over a section of highway and indicates the consistency that might be expected. Fig. 5 shows all of the data for a series of runs over one of the sections of road and illustrates the complete record for one vehicle on the highway. About thirty-five such diagrams were made up in the course of the investigations.

Tentative Theory of Grades—A consideration of all of the data so far obtained indicates that if only speed and fuel economy are considered the most economical grades will be those complying with the following:

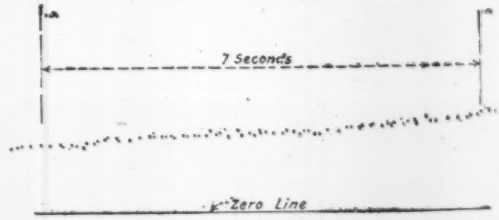


FIG. 2—PART OF RECORD FROM FLOW METER

A. The grade should permit the vehicle to descend without using brakes and without attaining an unsafe speed.

TABLE I—QUANTITY OF GASOLINE USED IN ASCENDING HILLS
(Fourth Gear is "high," First Gear is "low")

Run	P. C. Grade	Gear	Vert. Dist. Traveled, Ft.	Ton-Miles per Gal.		Ton-Miles on 0.0 Grade in High Gear
1	5.1	2d	602	11.4		
2	5.1	2d	536	11.25	11.22	29.7
3	5.1	2d	418	11.00		
4	3.7	3d	561	14.2		
5	3.7	3d		12.2	13.2	29.7
6	5.8	2d	590	7.5		21.2

B. The grade should permit the vehicle to ascend without the necessity of shifting gears and at a speed that will give maximum economy of operation of the motor.

The above principles are in conflict, since in general the grade that will comply with (A) will be lower than required by (B). The exact values for the per cent of grade for each condition will depend upon the allowable variation in speed of vehicle, the rolling resistance of the road surface and the tractive effort of the vehicle at efficient motor speeds.

The conditions established by the statements in (A) can be put in equation form as follows:

For automobiles,

$$P_m = \frac{3.47}{L}(S_2^2 - S_1^2) + \frac{R}{20} \qquad (1)$$

For commercial vehicles,

$$P_m = \frac{3.63}{L}(S_2^2 - S_1^2) + \frac{R}{20} \qquad (2)$$

where P_m is the maximum economical *minus* grade in per cent; S_1 and S_2 are the initial and final speeds of the vehicle in miles per hour; R is the rolling resistance of the vehicle in pounds per ton, and L is the length of grade in feet. Equation 1 applies to automobiles and equation 2 to commercial vehicles. The differense is wholly in the constant and that difference is due to the difference in the moment of inertia of the rotating parts of the two classes of vehicle. For an automobile the kinetic energy due to rotating parts is taken at 5 per cent of that due to translation and for commercial vehicles 10 per cent of that due to translation. These are average values for the vehicles used at Ames.

The conditions set forth in (B) may be put in equation form as follows:

For automobiles,

$$P_p = \frac{T}{20} - \frac{R}{20} + \frac{3.47}{L}(S_2^2 - S_1^2) \qquad (3)$$

For commercial vehicles,

$$P_p = \frac{T}{20} - \frac{R}{20} + \frac{3.63}{L}(S_2^2 - S_1^2) \qquad (4)$$

where P_p is the maximum economical *plus* grade in per cent; T is the tractive effort of the vehicle at maximum motor efficiency in high gear, and the other symbols have the same significance as in equations (1) and (2).

In order to compute the maximum minus grade for any location and vehicle, it is necessary to assume values for S_1 and S_2 and to use the value of R applicable to the particular surface. P_m can then be computed. Likewise in computing P_p for any location S_1 and S_2 must be assumed and the proper values for R and T determined. Grades computed in this way will comply with the principles set forth in *A* and *B*.

Since the public highway is utilized by an exceedingly heterogenous traffic, one must assume average or typical vehicles to serve as a basis for determining specific values for the per cent grade to adopt in any

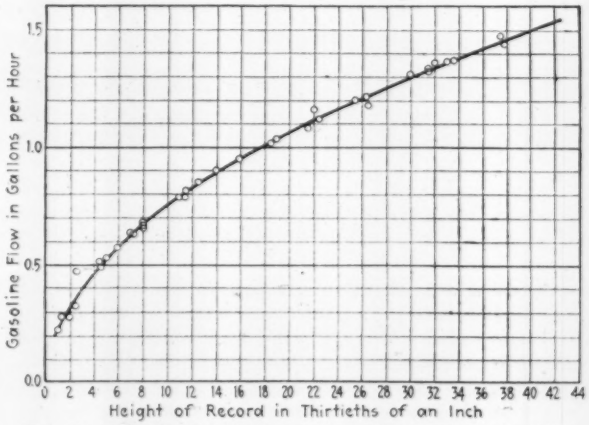

Gasoline Flow in Gallons per Hour
0.0
0.5
1.0
1.5
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44
Height of Record in Thirtieths of an Inch

FIG. 3—CALIBRATION DIAGRAM FOR AMES GASOLINE FLOW METER, BUICK MODEL

particular case. This we have ventured to do and the data in Table II and Table III represent our conception of a composite automobile and a composite commercial vehicle. The most variable factor is tractive effort. At maximum motor efficiency, in high gear, the value of tractive effort is quite a variable for different classes of vehicles and the tractive effort on gears other than high gear is still more variable.

The factor R is the sum of the rolling, air, and internal resistances up to the clutch. This does not vary widely for different vehicles but does vary with the character and condition of the road surface, the temperature and the speed.

The characteristics of the composite vehicles have been adopted after an exhaustive study of all available data and are offered as the first step in arriving at what may eventually be established as truly typical vehicles.

The significance of equations (1) and (2) is illustrated by the curves in Fig. 6. These curves are obtained by applying the characteristics of the com-

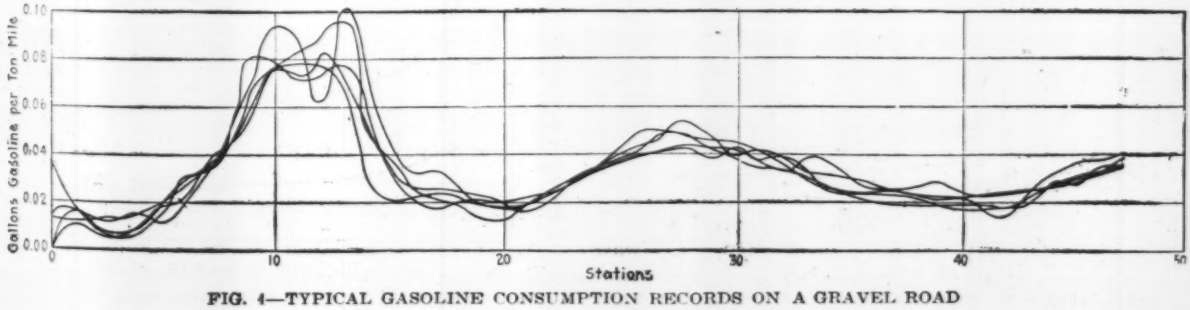


FIG. 4—TYPICAL GASOLINE CONSUMPTION RECORDS ON A GRAVEL ROAD

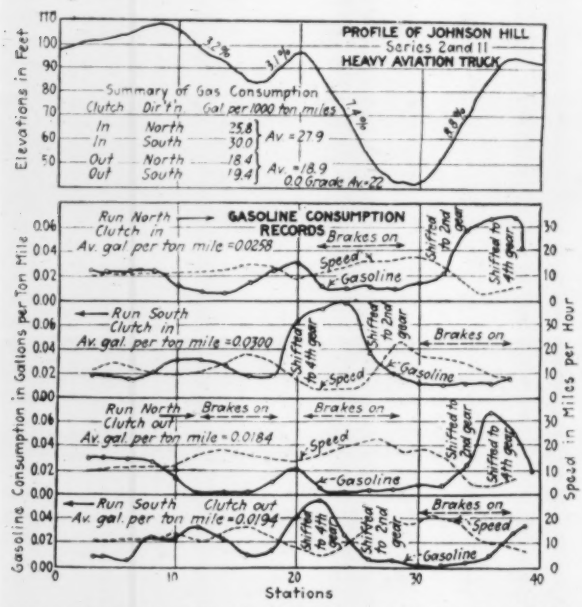

PROFILE OF JOHNSON HILL
Series 2 and 11
HEAVY AVIATION TRUCK
Summary of Gas Consumption
Clutch Dir'n Gal. per 1000 ton miles
In North 25.8 Av. = 27.9
In South 30.0
Out North 18.4 Av. = 18.9
Out South 19.4
0.0 Grade Av. = 22
Elevations in Feet
GASOLINE CONSUMPTION RECORDS
Run North Clutch in Av. gal. per ton mile = 0.0258
Run South Clutch in Av. gal. per ton mile = 0.0300
Run North Clutch out Av. gal. per ton mile = 0.0184
Run South Clutch out Av. gal. per ton mile = 0.0194
Brakes on
Speed
Gasoline
Shifted to 2nd gear
Shifted to 4th gear
Gallons Consumption in Gallons per Ton Mile
Speed in Miles per Hour
Stations

FIG. 5—TYPICAL PERFORMANCE ON HIGHWAY SECTION

posite vehicles to the equations and represent truly the economical maximum minus grades for the composite vehicles operating on paved road surfaces. In the same way the curves in Fig. 7 have been calculated to represent the actual economical plus grades for the composite vehicles.

In practice the maximum plus grade will first be determined. This represents the maximum allowable grade for the highway. But the allowable plus grade for automobiles will be much higher than for commercial vehicles and which shall govern will depend upon the character of the traffic on the particular highway.

The maximum minus grades will next be determined and these are nearly the same for automobiles and commercial vehicles. It now remains to determine whether the grade shall be made to conform with the maximum plus grades or the maximum minus grades. This is purely a matter of cost. The expenditure that may be justified for reducing the grades from the maximum plus grade to the maximum minus grade may be estimated as follows:

Let H equal the number of feet the total height must be reduced to change the grade from a maximum plus grade to a maximum minus grade.

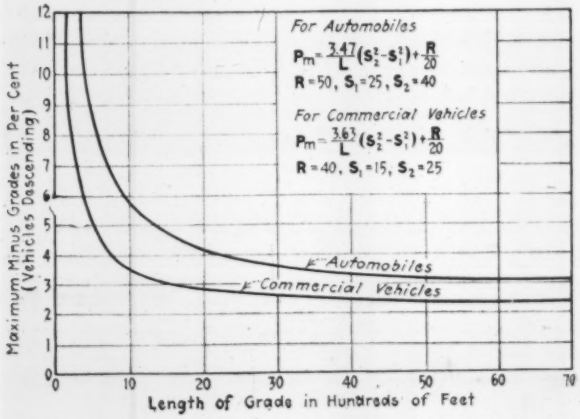

For Automobiles
$P_m = \frac{3.47}{L}(S_2^2 - S_1^2) + \frac{R}{20}$
R = 50, S_1 = 25, S_2 = 40
For Commercial Vehicles
$P_m = \frac{3.63}{L}(S_2^2 - S_1^2) + \frac{R}{20}$
R = 40, S_1 = 15, S_2 = 25
Automobiles
Commercial Vehicles
Maximum Minus Grades in Per Cent (Vehicles Descending)
Length of Grade in Hundreds of Feet

FIG. 6—MAXIMUM GRADES FOR DESCENDING VEHICLES

V = the annual traffic in millions of tons descending the hill.

C = cost of gasoline in dollars per gallon.

D = justifiable expenditure in dollars for reducing the grade.

Then
$$D = 5{,}200HVC \qquad (5)$$

Equation 5 is based on an average thermal efficiency for the composite vehicle of 10 per cent and 19,000 lower B.t.u. per pound for gasoline and the actual saving is capitalized at 4 per cent.

Usually D would be determined separately for automobiles and for commercial vehicles since the value of H would be slightly different for the two types of traffic.

Summary—The foregoing is intended to introduce a tentative economic theory of highway grades. The

TABLE II—CHARACTERISTICS OF COMPOSITE COMMERCIAL VEHICLE

Speed Range Mi. per Hr. High Gear	Tractive Effort on Gears, Lb. per Ton High	3d	2d	Low	Roll Internal and Av Resist. Lb. per Ton Grav. Mac Pav'ts	Earth
15 to 25	130	160	250	380	40	55

Comparative Fuel Consumption on Various Gears
(Average of five series of runs)

Type of Vehicle	Ton-Miles per Gal. Gas Paved Surfaces Low Gear	Second Gear	Third Gear	High Gear
Truck, solid tires	9.0	16	25	30
Truck, pneumatic tires	11	15.0	22	30
Average	10	15.5	23.5	30

Relative Speeds with the Several Gears

Gear	Speed, M.P.H.	Per Cent of High Gear Speed
High	25	100
3d	15	60
2d	8.75	35
Low	5	20

value of the deductions depends upon the sufficiency of the experimental data and the accuracy of the assumptions relative to the characteristics of the composite vehicles. There has been analyzed a great mass of data bearing on the subject, and extensive field investigations have been in progress for three years, but the subject involves so many variables that the results presented herein can hardly be considered more than the first step in the establishment of an adequate theory of highway grades. Amplifications and refinements to the theory will be made by those interested as rapidly as pertinent experimental data are available.

If the principles presented herein are considered in connection with trunk-line highways, where the annual traffic may reach several million tons, it will be appar-

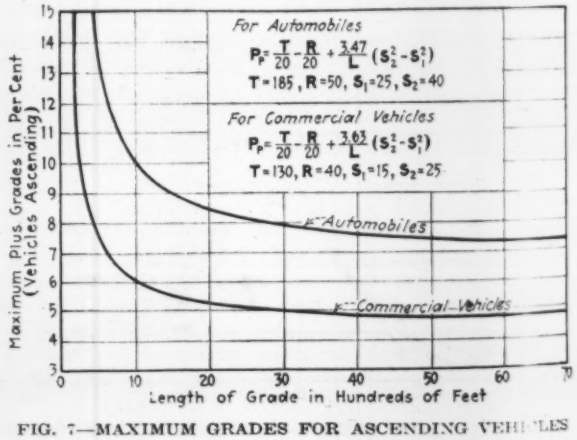

For Automobiles
$P_p = \frac{T}{20} - \frac{R}{20} + \frac{3.47}{L}(S_2^2 - S_1^2)$
T = 185, R = 50, S_1 = 25, S_2 = 40
For Commercial Vehicles
$P_p = \frac{T}{20} - \frac{R}{20} + \frac{3.63}{L}(S_2^2 - S_1^2)$
T = 130, R = 40, S_1 = 15, S_2 = 25
Automobiles
Commercial Vehicles
Maximum Plus Grades in Per Cent (Vehicles Ascending)
Length of Grade in Hundreds of Feet

FIG. 7—MAXIMUM GRADES FOR ASCENDING VEHICLES

ent that the actual value of the fuel saved by grade reduction may reach very significant sums.

The value of lost time due to excessive grades is an even larger sum, where the volume of commercial vehicle traffic is large, and undoubtedly a similar loss

TABLE III—CHARACTERISTICS OF THE COMPOSITE AUTOMOBILE

Speed Range Mi. per Hr.	Tractive Effort on Gears, Lb. per Ton			Roll Internal and Air Resist., Lb. per Ton	
	High	2d	Low	Pav'e. Grav., Mac., Earth	
25 to 40	185	400	600	50	65
Relative fuel consumption on the various gears in	High gear 26, 2d gear 20, low gear 14.				
Relative average speeds on the several gears	High gear 100, intermediate 65, low 35				

accrues to a considerable percentage of the automobile traffic. It is highly important to establish a basis for evaluating lost time, but it is one of those elusive quantities that are difficult to analyze and we have as yet made little progress in that direction.

It seems to have been established that momentum grades on rural highways are economical both from the standpoint of fuel and time and that, under certain circumstances, less fuel will be required on a road with an undulating grade line than on one with very flat grades.

Fuel cost is an item amounting to only fifteen or twenty per cent of the cost of operation of a motor vehicle, but a saving of one-tenth of the fuel annually consumed in a state will amount to a large sum.

Almost invariably those things that lower fuel consumption also lower maintenance costs for the vehicle and the road, thus indirectly effecting a saving in repair bills and tire wear, which is considerably larger than the fuel saving.

One interesting fact brought out in the fuel consumption runs was the marked saving in fuel that results from coasting down hill with the motor declutched. This is a perfectly feasible way to drive an automobile but may be dangerous with a commercial vehicle. It should not be practiced with any kind of vehicle on long grades or where safety considerations require the vehicle to be kept under control.

Safety, aesthetics and drainage considerations are outside the scope of this investigation, although they are factors that must always be considered in connection with grade reduction.

Bates Road Test Develops New Slab Design in Illinois

Edges of Slab Three Inches Thicker Than Center—Requires Less Concrete—Cost per Mile Reduced—Strength Increased

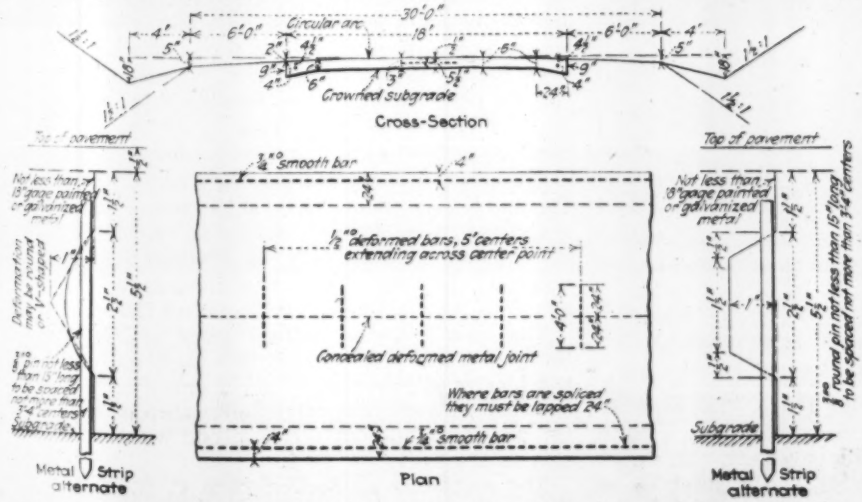
NEW designs for concrete roads and concrete base for asphalt-surfaced roads have been adopted by the Illinois Division of Highways as the result of observations on the Bates Test Road near Springfield, Ill Precisely the same section and joint arrangement and the same 1:1½:2 concrete are employed for concrete road and concrete base. As the drawing shows, the revised cross-section provides for a thickness of 9 in. at the edges of that pavement, tapering to 6 in. at a distance of 2 ft. from the edges, and the remainder has a uniform thickness of 6 in. The amount and arrangement of reinforcement is the same as that heretofore used, with the exception of the center-joint material, which is of new design to correspond with the 6-in. center thickness.

This new cross-section was adopted as a result of the Bates road tests, which show conclusively that the strength of the edges of any rigid pavement, built in accordance with any design heretofore used in Illinois, is much less than the strength of the interior portion of the slab. The Bates tests disclosed the fact that a center thickness of 6 in. or even perhaps 5 in. is ample to support the legal load limit provided by Illinois statutes. The new cross-section takes advantage of this fact. The tests further indicate that even with a 6-in. thickness for the main portion of the slab, a 7-in. edge with the ¾-in. longitudinal bar would still not be as strong as the mid-portion of the slab. The edge thickness has, therefore, been increased.

Particular attention is called to the fact that the new cross-section provides 1 sq.ft. less of cross-sectional area than a slab having a 7-in. uniform thickness. This means that the new cross-section will require 195½ cu.yd. less concrete per mile of pavement than the standard 7-in. design heretofore used.

The designers believe, therefore, that the new cross-section will provide a pavement which not only is better able to support trucks loaded to the legal limit, but will also reduce the cost per mile. The extra cost of shaping the subgrade for the new cross-section is small, as subgrading machines may easily be adapted to cut the subgrade to the new form. Even should the subgrade be cut to the usual crown, at an elevation 6 in. below the top of the forms, and the dirt along the edges then thrown out by hand, the added cost is slight.

All road bids in Illinois since Oct. 31 have called for the construction of the new cross-section Frank T Sheets is superintendent of highways for Illinois and Clifford Older is chief highway engineer.


Circular arc
30'-0"
Crowned subgrade
Cross-Section
Top of pavement
¾" smooth bar
½" deformed bars, 5' centers extending across center joint
Concealed deformed metal joint
Where bars are spliced they must be lapped 24"
Plan
Not less than 18 gage painted or galvanized metal
Subgrade
¾" round pin not less than 15" long to be spaced not more than 3'-4" centers
Metal Strip alternate

ILLINOIS STANDARD CONCRETE SLAB DESIGN DEVELOPED BY BATES ROAD TESTS
This section requires 195 cu.yd. less concrete per mile of 18-ft. road than a uniform 7-in. slab

From Job and Office

Hints That Cut Costs and Time For the Contractor and the Engineer

Half-Width Concrete Pavement Is Laid with Unusual Speed

BY THOMAS J. WASSER
State Highway Engineer, Trenton, New Jersey

STATE Highway Route No. 1, between the city of New Brunswick and the borough of Metuchen, New Jersey, is one of the most heavily-traveled roads in the state; and is a part of the Lincoln Highway. The nature of the subsoil through this country is such that unusual construction was necessary. In order to insure proper underdrainage to avoid breaking up of the pavement, through a combination of frost action and very heavy traffic to which the road is subjected, a 6-in. layer of compacted foreign material was required, through which it would be possible for any subsurface water that works up under the road bed to reach the underdrains built along each edge of the pavement and running parallel thereto. Slag or clean steam cinders on this particular job were specified as the foreign material, and for the most part, steam cinders were used.

The pipes in the longitudinal underdrains were carefully laid to line and grade, and inspection holes, constructed of concrete, were spaced at frequent intervals, to allow inspection of the underdrainage system, which will make it possible for the forces responsible for maintenance of the highway to be constantly advised regarding the effectiveness of the drainage system.

The pavement consists of 2 in. of bituminous concrete on a 9-in. portland cement concrete base, without reinforcing, mixture of concrete being 1:3:5. The concrete curb is poured monolithic with the pavement to a depth of 15 in., or 6 in. below the main pavement. This curb holds the cinder sub-base in place, and at intervals of 10 ft., longitudinally, 5 x 5-in. openings through the curb allow the water which might accumulate under the pavement to reach the longitudinal french drains at the side of the road. A 2-in. projection is built above the concrete base to provide a shoulder for the bituminous concrete, level with the top of the finished pavement.

HALF-WIDTH CONCRETE ROAD ON LINCOLN HIGHWAY

The deep concrete curb acts as a header to retain the cinder fill put on the subgrade to facilitate subsurface drainage. Despite the fact this section is one of the most heavily traveled in New Jersey, traffic was expeditiously handled and at the same time a daily average of 400 ft. of 16-ft. pavement, together with two concrete headers, was maintained on one of the two contracts.

The pavement being built one half at a time, requires the construction of a curb in the center of the finished pavement, constructed the same as the curb along the side. This 6-in. width of portland cement concrete being light in color, makes a strong contrast with the bituminous concrete, and serves the double purpose of supporting the edge of the bituminous concrete and dividing the width of the concrete slab, and also is an important factor, from a traffic standpoint, in furnishing a permanent division mark down the center of the pavement.

The progress of construction on this section, under the traffic conditions, was unusual. One-way traffic was maintained on the old road bed, while construction was in progress on the other half of the right-of-way. Maintaining traffic, of course, limits the effectiveness of the construction forces, but in spite of this condition, a daily average of 400 lin.ft. of 16-ft. pavement, including two header curbs, has been maintained on one contract, known as Section 13 of Route 1, with a maximum daily run of 500 lin.ft.

The total length of the road was 4.74 miles. Due to the lateness of the season in which work could proceed, it was divided into two contracts, known as Sections 13 and 14, of Route 1. The total length of Section 13 was 2 miles. Total width of pavement varied from 32 to 42 ft. The total number of square yards of pavement in this section was 32,711. The construction of this section was started Aug. 22; and paving work was started Sept. 27. To Dec. 6, 19,888 sq.yd. of pavement had been laid. Section 14 was 2.74 miles in length, and the width 32 to 40 ft. An average of 500 lin.ft. of concrete base was laid per day, and a maximum of 583 ft. of 9-in. 1:3:5 concrete, mostly 16 ft. wide. The total number of square yards of paving in this contract was 49,855. Work on the contract was started Aug. 18; and paving work was started Sept. 23. The number of square yards completed to Dec. 6 was 28,434.

On Section 13, 2 miles in length, the paving of one side was completed in 42 days, or between Sept. 27 and Nov. 8. Section 14 was completed in 49 days, or from Sept. 23 to Nov. 11.

The location of the work being within truck haul of the boat wharf where barge shipments of sand, stone, and cement were received, played an important part in the speed of the work. On one section, however, it was necessary to receive cement shipments by rail. No materials were allowed to be stored on the subgrade.

The Yale-Princeton football game of Nov. 18 presented a traffic problem over this important section of the Lincoln Highway of no small proportions, but this tremendous traffic was carried over the finished half of the pavement, without accident, and without interruption to the work.

The contractor on Section 13 is C. H. Riddle, New Brunswick, New Jersey, and the contractor on Section 14 is S. S. Thompson, Red Bank, New Jersey.

Centralized Control of Road Building

By J. T. Hallett
Road Engineer, Indiana Highway Department, Indianapolis, Indiana

IN THE spring of 1920 the construction division of the Indiana State Highway Commission created five residencies through which road construction was supervised throughout the state. Each resident engineer had an office force and a field force consisting of a project engineer and one or more inspectors on each federal-aid project, and an inspector on each county-aid project where the department was in charge of inspection only.

The project engineer and inspectors reported to the resident engineer in charge who condensed reports and sent them to the main office, thus having only part of his time available for supervising his project engineers.

With the resident supervision the engineer in charge of the project was required to make out the estimates of work done about the twenty-fifth of the month and submit them to the resident engineer for his check and approval before they were forwarded to the main office. There they were again checked before being forwarded to the auditor's office for payment. This method required about fifteen day's time from the date estimates were made until the contractor had received his money.

For the size of the program (about 120 miles) at that time it was found that the cost was too great, compared with the results obtained. In the fall of the same year the residencies were discontinued and all supervision was handled from headquarters. The road engineer spent all his time visiting and supervising the project engineers and inspectors. All reports were made direct to the chief engineer at the main office by the project engineers. This continued throughout the year of 1921. In the spring of 1922 an assistant road engineer and a general inspector were appointed to help the road engineer in his field supervision. Also, three supervising engineers were appointed, to each of whom was assigned a number of projects.

The state is of such size (all parts being so easily accessible) that where the road program increased in any amount it could be handled by increasing the number of supervising engineers and inspectors.

The centralized control has resulted in less cost of supervision, more uniform results throughout the state, and has enabled the chief engineer to get reports on the work quicker and more directly. Another result of the newer system is that the project engineer makes up estimates on the twenty-eighth and they are paid in from eight to ten days.

Ten Short Highway Articles By—

1-Thomas J. Wasser
State Highway Engineer of New Jersey

2-J. T. Hallett
Road Engineer, Indiana State Highway Department

3-C. M. Hathaway
Engineer of Construction, Illinois Division of Highways

4-A. W. Dean
Chief Engineer, Massachusetts Division of Highways

5-G. H. Henderson
Office Engineer, Rhode Island State Board of Public Roads

6-G. E. Wright
Assistant City Engineer, Gloversville, N. Y.

7-Crosby Tappan
Superintendent of Construction, Pennsylvania State Highway Department

8-H. K. Davis
Chief Inspector, Iowa State Highway Commission

9-L. A. Reindollar
Engineer of Surveys, Maryland Roads Commission

10-F. D. Messenger
Contract Engineer, Michigan State Highway Department

Hauling Water on Concrete Paving Jobs

By C. M. Hathaway
Engineer of Construction, Illinois Division of Highways, Springfield, Illinois

IN EXTREME level country, such as exists in many places in Illinois, one of the chief difficulties of the paving contractor during the dry summer months is the securing of a sufficient water supply to operate his paver and to cure the finished pavement. This feature may be seemingly of minor import to the average person, yet an ample supply of water is one of the first items which the contractor gives careful consideration in making up his estimate in bidding.

During the past season several contractors have overcome this scarcity by shipping in water in tank cars, a scheme which is, of course, limited—dependent upon the length of rail haul from some large city which has available a comparatively inexhaustible water supply at reasonable cost.

In one instance noted, the job was located about fifteen miles from a large city where an available supply of water could be secured at a very reasonable meter rate. Tank cars of 8,000-gal. capacity were used, which cost the contractor a flat rate rental of $2 per day, plus an initial freight charge to and from Chicago of about $50 per car. The freight on a tank of water for the fifteen miles, by local shipment, was $10 per car, and the actual cost of the water, by meter, 15c. per 100 cubic feet.

The contractor had dug at his plant a pond or reservoir into which the contents of the tank car were discharged and from which the water was pumped direct to the pipe line. The local freight would bring out two or three tank cars daily, as required. These tanks would be discharged during the day, into the reservoir and the empties would then be hauled back by local freight the same day or the following morning. Thus, six or eight tank cars sufficed to handle a job of ordinary magnitude.

Although there are no definite figures as to the cost per square yard on this particular job, a short section (one-half mile in length) constructed by force account did cost about 7c. per square yard for water hauled in this manner, which figure is unquestionably nearly double the figure which might be anticipated on an ordinary paving section where the fixed charges would be distributed over a greater yardage and where greater economy could be effected in handling.

This year's experience, however, on several jobs, would indicate that this method of furnishing water, which has heretofore been considered entirely out of reason due to the cost, may under favorable conditions be utilized to advantage in other instances.

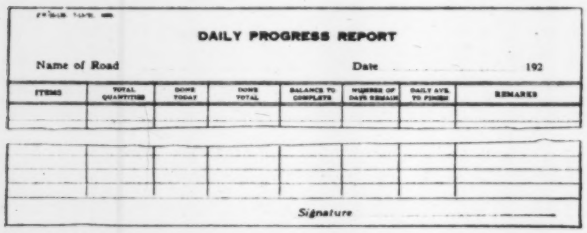
Co-Operation Between Field and Office on Highway Construction Progress

By A. W. Dean

Chief Engineer, Massachusetts Department of Public Works, Division of Highways, Boston

OUR system on important work provides for close touch between the main office and the progress of the work outside. In securing this, provisions are made in the contract for certain progression and this is followed up by means of daily and weekly reports.

The daily report is made out by the resident engineer directly in charge of and located on the work,


DAILY PROGRESS REPORT

Name of Road Date 192

ITEMS	TOTAL QUANTITIES	DONE TODAY	DONE TOTAL	BALANCE TO COMPLETE	NUMBER OF DAYS REMAIN	DAILY AVE. TO FINISH	REMARKS

Signature

FIG. 1—DAILY REPORT OF RESIDENT ENGINEER

Copies of this report are sent to the chief engineer, the district engineer and the contractor. One copy is retained by the resident engineer.

and a copy is mailed each day to the office of the chief engineer, the office of the district engineer, the contractor, and one kept in the files of the resident engineer. The weekly report, which is virtually a progressive chart, is made up at the district engineer's office. It is kept there in the form of a tracing which is blueprinted each week and blueprint copies are mailed by the district engineer to the resident engineer, contractor, and the chief engineer's office.

From Job and Office

Hints That Cut Costs and Time

We find that the contractor values greatly the information which he obtains from these reports and charts. By these means the various elements of the work are each given their relative importance when the progress is considered. Any elaboration desired may be accomplished on the graphic chart, as for instance, where one-half of the roadway has to be constructed before the other half is done to provide for traffic, and when a concrete road is being constructed where two or more mixers are in operation at the same time on several sections.

It is obvious that work must be planned and usually contractors require assistance in this planning or laying out of the work before it is done. By comparing the actual progress with the graphic chart showing the ideal desired, opportunity is given for correction.

Use of Photography and Other Features in Hastening Road Plan Completion

By G. H. Henderson

Office Engineer, State Board of Public Roads, Providence, Rhode Island

OFFICE engineering in the state highway department of Rhode Island has been carried on under three severe handicaps—lack of space, lack of help and lack of light. The first feature is the most serious because, with quarters at least double the capacity we now have, we probably could eliminate the second.

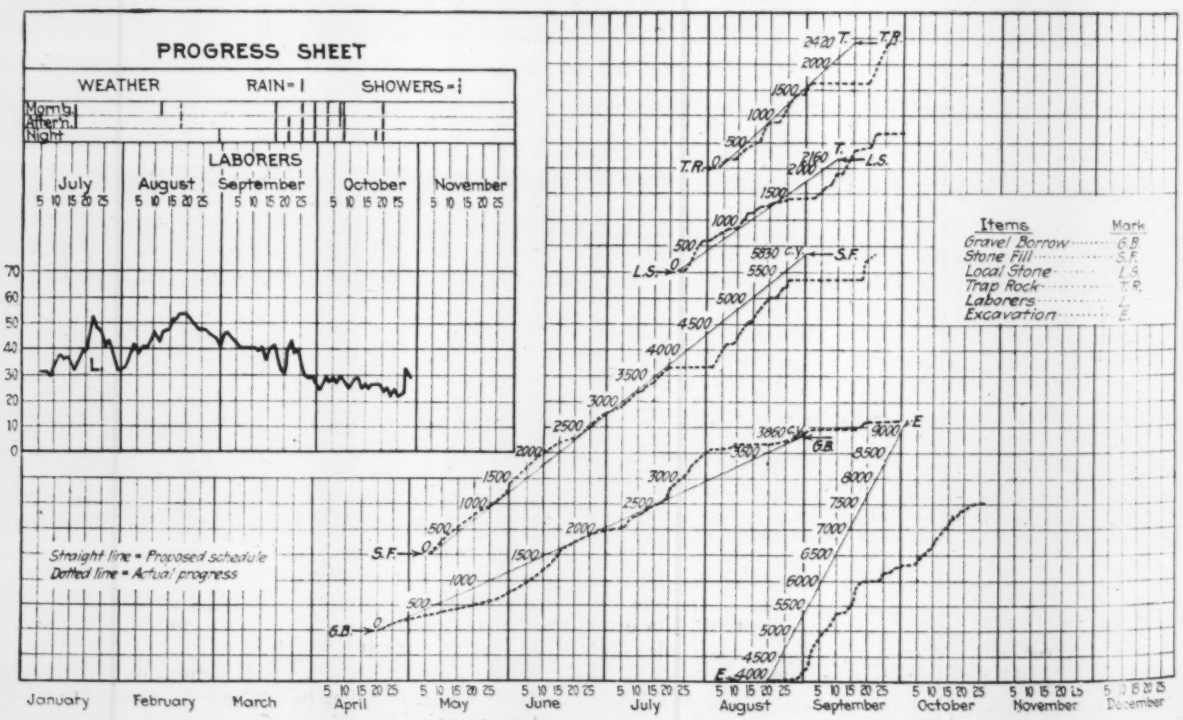


FIG. 2—PROGRESS IN ROAD CONSTRUCTION CHECKED AGAINST IDEAL PLAN

Every principal item in the contract has been planned and its ideal progress charted. As the work proceeds means are at hand to speed up here and there to approximate the ideal progress.

From Job and Office

For Contractor and Engineer

Owing to the congestion in our drafting room, it is difficult to divide all of our work into classes and to delegate permanently the various classes of work to separate forces, although this is done as far as practicable. The various branches of our work are carried on simultaneously with concentrated effort upon the jobs nearing completion. Lack of space, in limiting our force, sometimes requires working overtime. Our conditions are such that we constantly are on the alert for short cuts and the elimination as far as possible of duplication of labor. As our state is small, smaller than many single divisions in some other states, our engineering for the whole state is centralized in the one office and all plans, designs, specifications, etc., are prepared in this office.

The principal plans or tracings for each of our projects are as follows: First, a plan and profile for each and every mile, plotted to a scale of 40 ft. per mile horizontal and 8 ft. vertical and drawn on a sheet of heavy detail paper 36 in. wide and 14 ft. long; second, cross-sections for a mile of road corresponding to that on the plan and profile, drawn to a scale of 1 in. per foot on a roll of profile paper of medium thickness and 22 in. wide; third, plans to accompany drainage agreements; fourth, plans for land condemnation; and fifth, construction plans laid out to satisfy federal standards as well as our own.

Relations between the surveying parties and the office are close and conferences concerning locations are more or less frequent before and during the survey. The office therefore has first-hand knowledge as to how best to lay out the traverse and profile to take care of possible realignments during the design.

All attention is first focussed on the main detail plan and the cross-sections and these are plotted, checked and inked as rapidly as possible, for these are the plans used in the design and finally they become the record plans for the office. The size and scales used we have found most convenient in our fielding work as we deem it desirable to have upon a single sheet at least one mile of road in order to get a proper perspective of location and grades. All proposed drainage structures are sketched on the plan as soon as fielded for design. Then the plan is immediately photographed in sections and reduced to a convenient size for handling. This enables our right-of-way man to have a copy long before tracings could be made, and enables him to look up ownerships along the highway or proposed right-of-way both for proposed new drainage flowage on private property and for possible land condemnation.

The owners of land upon which new surface water flowage is proposed are interviewed first and agreements reached as soon as possible. As there is no law in this state that permits us to cause the flowage of surface water on a person's land without his consent, failure to agree with the owner means change in design. This use of photography more than justifies its expense for it hastens final determination of drainage structures, lines and grades. All questions as to location of new structures are speedily answered and we do not lose the use of the plans longer than is necessary to photograph them. It is *always* bad to have delays in final completion of plans, but in our congested quarters it is *disastrous*.

In the case of cross-sections one plotting suffices in our scheme, the roll being marked off in 36-in. lengths, which is standard for federal aid and also for our own construction plans, and the sections are plotted within the sheet limits. The roll is printed in one operation and the prints cut to the standard lengths.

All other plans and profile except special detail sketches which are drawn to special scales are traced from the original large detail plan.

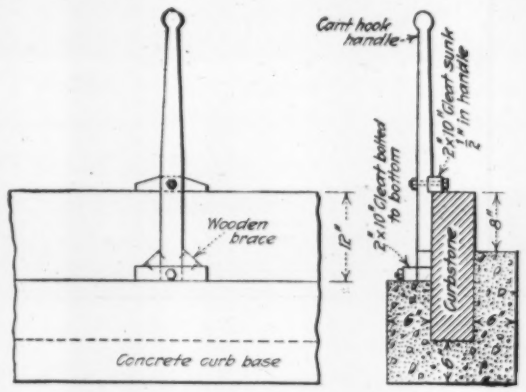
Simple Tool Regulates Depth of Concrete in Curb Base

By G. E. Wright

Assistant City Engineer, Gloversville, N. Y.

While setting curb in concrete on the paving jobs of Gloversville, it was discovered that the base concrete was often left too high on the front side of the curb. When the expansion joint was placed the base concrete either had to be cut away at considerable labor and expense, or the joint would protrude above the pavement. To overcome this bad condition, William Karg, the sub-contractor who did the curb setting, devised a simple tool the use of which eliminated the above-mentioned condition.

The tool was made of a handle of an old cant hook sawed off about 3 ft. from the top. A cleat about 10 in. long was set into the side of the handle 12 in. from the bottom. This cleat projected from the cant-hook handle about 1½ in. and was bolted through to make firm connection. Another cleat was fastened to the bottom of the handle, making the distance between the



TOOL CONTROLS GRADE IN PLACING CONCRETE

bottoms of the two cleats 12 in., or the height of curb top above finish grade in the curb base. The bottom cleat was braced to keep it at right angles to the handle. The lower cleat was shod with galvanized iron.

As the base concrete was poured the tool was used to ram the concrete down to grade where it was too high. In case concrete was not poured to grade, the tool discovered such sections.

The work was done in connection with the city's season paving program by Morrell Vrooman, Inc., general contractor. G. M. Nagany was in charge for the contractor with the writer in direct charge of the work for the city under H. J. Hanmer, city engineer.

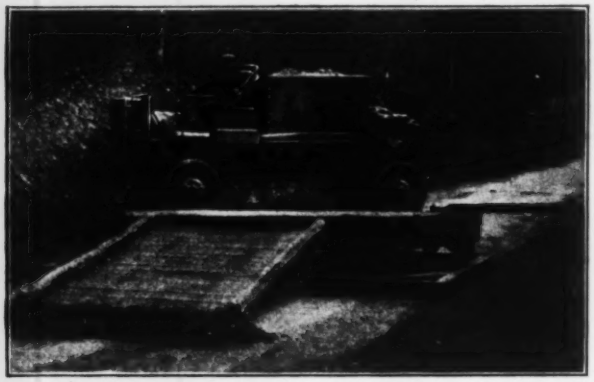
Turntable Used in Concrete Road Work Is Made From Industrial Flat Cars

By Crosby Tappan
Superintendent of Construction,
Pennsylvania State Highway Department,
Harrisburg, Pa.

THE PENNSYLVANIA State Highway Department, through its construction bureau, has recently completed concreting 22½ miles of road between Trout Run and Blossburg, Pennsylvania. All material had to be imported and the only railroads were located at the two ends of the job, so that all materials had to be hauled over the road. For transporting materials it was decided to use a combination of trucks and industrial railroad, carrying loaded batch boxes on trucks as far as the concrete was cured and ready for use, and there transferring the batch boxes to narrow-gage railroad cars. The cars were then hauled by locomotives to the mixer.

The trucks at the disposal of the department were of such length that they required considerable space in which to turn, and this being lacking on the roadbed without the use of mechanical means, it was decided to use a turntable for turning the trucks.

There were available former Army narrow-gage flat cars with platforms about 24 ft. long and 6 ft. wide. Two such car platforms were taken from off their trucks and a home-made center bearing placed under each. Under each end of the platform were placed two car wheels, which were provided with short axles working in suitable boxes. A wooden framework about 18



TRUCK TURNTABLE MADE FROM NARROW-GAGE CARS

ft. square was provided, on which a circular rail was spiked. To permit trucks to get on and off the turntable, wooden ramps were built.

As it was necessary to move the transfer station including the turntable once a week on an average, rollers similar to timber buggies were placed under the frame carrying the circular track, and the whole was pulled ahead to its new location by a truck. This turntable was turned with a fully loaded truck on it by one man and gave first-rate service during the whole length of the job.

Reproduced herewith is a photograph showing this turntable in operation. The total cost of each turntable, exclusive of the flat car platform and wheels, which, as stated above, had been turned over by the government to the highway department, was a little over $200.

From Job and Office

Hints That Cut Costs and Time

Preparing a Dusty Subgrade for Concrete

By H. K. Davis
Chief Inspector, Iowa State Highway Commission,
Ames, Iowa

IN NORTHWESTERN Iowa the highway construction season of 1922 was ushered in by a long-continued dry spell which, though perfect as construction weather as regarded speed alone, was the cause of many invectives by the engineers when quality of work was considered.

Miles of embankments, roughed in during this dry weather, lay in continuous piles of lumps and clods impossible to finish to any desirable shape; or, if traffic was permitted over the new dumps, the loose clods and earth wore into a series of bottomless ruts.

Where paving was to be laid this was a particularly troublesome condition. The specifications and inspection on such work are fairly rigid in Iowa and the inspector invariably insisted that this fine dust subgrade be spread smooth and true to cross-section and then be thoroughly wet before concrete could be laid.

It soon became apparent that ordinary treatment such as spraying the usual amount of water around the mixer was not satisfactory. If sufficient water were used to saturate two or three inches of dust it became soft mud which, under no circumstances, could be formed into a satisfactory subgrade. If less than this amount were used the unwetted dust beneath permitted the wetted part on top to stick to the feet of the workmen and the wheels of the trucks, making, if possible, a worse condition of soil from which to form a subgrade. Then, too, the mud was tracked into the concrete.

One engineer conceived the idea that wetting that particular material the evening before would allow the water to "settle down" to where it would leave the subgrade material moist but not muddy by the time work began the next day. It was tried and proved a complete success. The subgrade after that looked as if made of freshly excavated damp earth, was easily workable and remained well packed under the traffic.

An additional advantage was noted that converted the engineering force to the new scheme. There was a tendency during this dry period for the concrete to develop shrinkage cracks, or "checks." When thorough saturation of the subgrade was secured by the above described method the cracking ceased.

As summer advanced the dry weather caused a similar dusty condition on subgrades in other regions. The complete success of the treatment in northwest Iowa caused it to be adopted in other places. One type of soil gave trouble upon first trial. It contained a considerable per cent of sand and at first glance appeared to be a loam. Actually, when thoroughly wet it became very sticky and behaved like a gumbo. The next morning it was a loblolly. This nonplussed the sponsors of the scheme, but by the second day it was in fine condition to work. Thereafter, on this stretch of gumbo the wetting of subgrade was done two evenings ahead of the concrete and the contractor and inspector laughed at the dry weather.

From Job and Office
For Contractor and Engineer

Central Mixing Plant Used In Widening Macadam Road with 3-Ft. Shoulders

By L. A. Reindollar

Engineer of Surveys, Maryland State Roads Commission, Baltimore, Md.

TRAFFIC demands made upon public highways, particularly upon main traveled routes, often necessitate the use of novel means while reconstruction is going on. As many roads must be kept open while work is in progress construction or reconstruction of half the width of road at a time is becoming popular. This method, combined with the use of an efficient central concrete mixing plant, allowed an unusual degree of speed in widening with concrete shoulders a 12-mile section of existing macadam along the old National Pike between Frederick and Baltimore, Md.

The central mixing plant was established in about the center of the job, where a siding with a capacity of about ten cars was built. In about the center of this was erected a bin with a capacity of 200 tons, elevated about 66 ft. above the tracks. A pit was built under the tracks and material was dumped from the cars and conveyed to the bin by a specially-built bucket conveyor. The bin was divided into two compartments and sand and stone were diverted from the conveyor to the proper compartments by a chute operating on a swivel.

The bins were built so that material ran by gravity to a measuring hopper installed directly under them, emptying into a mixer of 1-cu.yd. capacity. Concrete was discharged from the mixer drum into trucks.

The original construction of the National Pike over this widened section was of macadam, 15 ft. in width, and with a crown of from ½ to ¾ in. to each foot of road width. The widened roadway was to have a crown of ¼ in. to each foot of width necessitating making the edge of the concrete higher than the edge of the macadam, and the digging of a shallow trench to subgrade.

The grading was done with a leaning-wheel grader equipped with a scarifier and blade and was pulled by an 8-ton caterpillar tractor. This mechanical outfit with ten men could prepare about 1,800 lin.ft. of subgrade per day.

A fleet of eight 5-ton trucks were used to haul the mixed concrete, and at no time was concrete in transit more than 30 min. before being put on the roadway.

The shoulders were built 3 ft. wide on each side throughout with the exception of the inside of curves, which were widened to 6 ft. All curves were banked. The 12 miles of shoulder on both sides were completed in 85 days—1,400 lin.ft. being the shortest day's run and 2,600 ft. being the maximum. Shoulders were built on one side of the road at a time and the macadam was built up adjacent to the shoulders by the state's maintenance forces, as soon as the concrete had cured.

In curing the concrete a motor truck equipped with a 600-gal. tank was used for sprinkling the concrete, which was then covered with a 2-in. layer of earth.

This work was done by Thomas, Bennett and Hunter, contractors of Westminster, Md., under the supervision of W. F. Childs, district engineer, Frederick, Md.

Policy in Advertising for Highway Bids

By F. D. Messenger

Contract Engineer, Michigan State Highway Department, Lansing, Mich.

THE Michigan State Highway Department has received many favorable comments from contractors and others interested in the state highway work concerning the method used by the department in advertising and receiving bids on state highway work. The efficiency of the system is apparent particularly during the early part of the construction season when there are a large number of contracts to be awarded.

By way of explanation it should be noted that the counties wherein the proposed construction is located pay a certain percentage of the total cost of the construction, which varies from 5 per cent to 25 per cent, depending upon the valuation of the county and the number of miles of trunk-line road within its borders.

Therefore, bids are received in all cases at the offices of the boards of county road commissioners by a representative of the state highway department. This tends to increase co-operation between the local authorities, the state highway department, and the contractor, as local authorities are, in many instances, better informed as to special conditions concerning projects, and are anxious to co-operate with contractors in informing them of these conditions. Also, bids are received close to the job and contractors can secure general information concerning sources of material, freight rates, etc., by mail and then go over the project on the ground just before the receipt of bids and be on hand at the time bids are opened without having to make a journey from the project to the state capitol.

The main point, however, is in the manner of handling the bids when a large number of projects are to come up at approximately the same time, and the method may be briefly outlined as follows:

Proposed projects in a certain section of the state are tabulated and a series of bids outlined which result in bids being received in one county seat generally on the second day in the week, with bids on the succeeding days at adjoining county seats. Bid openings are set for such hours that a contractor, traveling either by rail or automobile, can be on hand when bids are opened at one county seat, and, if he is not the low bidder, have time to look over the job in the next county and submit a bid the next day on that job, and so on throughout a series of bids covering in general four or five days. This makes it necessary for contractors to tie up in certified checks only a relatively small amount of money, as certified checks are returned as soon as bids are opened to all others than the two lowest bidders.

If bids are received on a large number of jobs at one time, small contractors may be able to bid on only two or three of the jobs and may be low on none, while other contractors may endeavor to bid on all of the jobs and be low on more than they can handle. And if they bid on several jobs the amount of money involved in certified checks becomes considerable.

It happens many times that there are several sizable projects on which bids are to be received at the same county seat and in that event bids on two or three of the jobs would be received in the morning and on the balance in the afternoon. The advantages of this detail are obvious.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Engineering, Salesmanship and Personality

Sir—Referring to the articles by A. R. Hirst and Major F. S. Besson in *Engineering News-Record* of Dec. 14, pp. 1030 and 1035, I wonder how many readers connected them up, mentally, as I did. Is it not true that too many engineers fail to use the elementals of salesmanship when they go before their boards with recommendations, often the result of many weary hours of endeavor to arrive at the best and cheapest way to do a certain piece of work? They seem to feel that their audience will understand the whole proposition as clearly as they themselves do; and they are disappointed and discouraged if they meet opposition. Let such projects be put down in black and white (or blue) and four times out of five some hard-headed member of the governing body will be won to the project and assist in putting it over too.

Personality is a great thing, and most valuable too, but I disagree with Mr. Hirst in putting it before education. There are already too many "engineers" with nothing but personality—and gall—who are directing the expenditure of public funds. In my judgment, this is the cause of that same public's dissatisfaction with public works in general, and road construction in particular. E. M. CLARKE.

Cranford, N. J., Jan. 1, 1923.

A Defense of "Sales Engineer"

Sir—The writer has read with much interest the protest by Mr. Bedell in your issue of Dec. 28, against the term "sales engineer," and also your editorial, because he would probably fall under this opprobrious classification. In his instance, the honorable and desirable portion of this title was achieved by means of a technical engineering education and fifteen years of what might be claimed without undue immodesty as fairly successful practice of the profession. An unfortunate degeneration into sales work is responsible for the undesirable prefix.

This letter seems to have been dictated according to the old idea, happily rapidly vanishing for the good of the profession, that the engineer belongs to a special haloed class with a corner on honesty, while all manufacturers and salesmen are of necessity crooks. It is stated in the letter that "the ethics of the two occupations are incompatible. Should an engineer use a salesman's methods, he would be accused of sharp practice." This is ridiculous. Honesty is not a question of vocation but of principle. Moreover, if some of the salesman's "savoir faire" and ability to get along with others could be acquired by the average engineer, there would be less friction than at present exists in many engineering departments.

It is further stated that "a salesman has little identity of interest with his customer," while an engineer "gives service to and is paid by the customer whose interests and his are one." This statement shows the complete lack of knowledge of business principles so often found among engineers and so unfortunate for the profession. It is axiomatic in any progressive business of today that the interests of the buyer and seller must be identical, that service must be given, and that a satisfied customer is the best possible asset. It is further stated "it is to be regretted that a name as soon as it gets a reputation that is at all advantageous, is borrowed or stolen by others for its reflected credit." This reminds the writer of a remark made to him while still a bona fide engineer by a salesman, who intended to be complimentary: "Do you know, somehow you don't look like an engineer."

It is a fact that the title "sales engineer" may be misapplied, just as the title "engineer" is often misapplied, but the evolution of the sales engineer is a legitimate development of modern day progress. As properly used the term may be applied to the man who, while he may sell a given commodity, is often called upon for the most technical sort of advice as regards the use, installation, or operation of his commodity. His technical knowledge is special and acquired through intensive technical training, and many times is far in advance of that of the engineer on his particular subject.

The engineer receives remuneration for the sale of his knowledge by means of a salary, while the sales engineer receives his remuneration through the sale of his product, which, as incomprehensible as it may seem to some, he may really and honestly believe to be the best possible for the service required. A. H. RHETT.

New York, Dec. 29.

Color and Harmless Bacteria in Water

Sir—A very interesting argument in favor of slow sand and against mechanical filtration of colored waters by C. M. Saville appeared in *Engineering News-Record*, Sept. 7, 1922, p. 380, and an abstract of a new method of color removal by slow sand, by H. W. Clark, in the same journal of Sept. 28, 1922, p. 514. Francis B. March, in Letters to the Editor, Oct. 12, 1922, p. 624, suggested that hydrogen-ion tests on reservoir water might save the cost of filtration. It is the writer's opinion that mechanical filtration is still the best method of color removal measured by work done in relation to cost of doing it, and chlorine treatment still the cheapest method of killing bacteria.

Water supplies have "color and harmless bacteria" because of the material on the earth over which the water has passed on its natural course to storage or use. The color is present because colored waters are generally soft and thus are excellent solvents for dissolved or colloidal matter, such as humic acids and decayed vegetable matter, and because the waters pass over soils or earth containing more of these substances than of finely suspended and colloidal clay. The "harmless bacteria" come from the decomposition of vegetable or organic matter.

Suspended particles of mineral or organic nature subside if their velocity is retarded sufficiently. Colloidal particles subside if they are transformed into larger size suspended form (i.e., increased in size in relation to mass weight) and dissolved particles subside if they are absorbed or enclosed by such substances as colloidal clay, aluminum hydrate or iron hydrate, or if they unite chemically with a substance or substances which will form settleable suspended particles, and if the velocity of the final reaction substances is sufficiently retarded.

Colloidal clay has some absorption power for dissolved and colloidal color, and for both dissolved and colloidal substances, but this property does not appear at present to have a value anywhere near as great as the absorption power of aluminum hydrate or iron hydrate.

In reservoirs there is, doubtless, some interaction between color and colloidal clay, but generally the latter is present in very small amounts compared with color. There is almost always some oxidation of color in reservoirs by the action of sunlight and dissolved oxygen and some subsidence of the interacting compounds. It would not be economical to subside much color or colloidal or suspended clay or alum hydrate or iron hydrate in an expensively constructed reservoir. The subsided color and organic matter would decompose and form noxious odors and tastes—perhaps iron sulphide—if they were large in amount so as to use up the oxygen of the water at the lower levels of the reservoir.

The pH concentration of most untreated waters is the resultant of free ions in balance as alkalinity bicarbonates acting against free carbon dioxide. If there is no free carbon dioxide in the water, there will be all bicarbonates or bicarbonates and normal carbonates, or else, in extreme cases, normal carbonates and caustic alkalinity, as when an excess of lime or caustic soda is present.

From the records of numerous experiments, it appears that alum hydrate begins to precipitate at a pH of about 4 and is complete at about 7, with the optimum isoelectric point at about 5.6. If a water has high alkalinity it might coagulate and precipitate excellently at 7 to 7.5, but it would coagulate with less aluminum sulphate and at less cost if the pH could be economically taken to 5.6 to 6. Sulphuric acid or carbonic acid will lower the pH economically.

In my experiments reported in *Engineering News-Record*, Sept. 7, 1922, p. 391, I carried the pH from 5.5 to over 7.5 and used chlorine to prevent the resolution of color by high soda-ash pH concentration. Soda appears to have a greater resolution power over aluminum hydrate than an equal amount of carbonate or hydrate of lime, measured by alkalinity. Soda ash causes no increase in hardness in the water but has less power to prevent corrosion than an equal amount of lime measured by alkalinity, but lime increases the hardness and the soap-consuming power of a water.

The natural alkalinity of most waters appears to be due to bicarbonates of lime and magnesia and in most mechanical filtration plants aluminum sulphate is added until a good floc is obtained without any attempt being made to control the pH unless it naturally happens to be low, when the best results are accidentally obtained. This is the reason why an advocate of slow sand filtration has such a good argument against mechanical filtration from the occasional poor results given by the latter. Generally, the poor results are not necessary.

Sunlight, carbonic acid and partly decomposed proteid organic matter promote algae growth. If the feeder brooks to a reservoir are treated with copper sulphate to kill or prevent algae growths the materials which promote growth are still in the water, and the same or a different species may develop in the reservoir later. This treatment also has a similar result when algae are killed in the reservoir itself. Algae are especially detrimental to long or even average runs between cleaning slow sand filters and without any aluminum hydrate in the sand to help remove color. At a large experimental slow sand filtration plant in Massachusetts, on a water with a color of about 40 to 50 on the platinum scale, turbidity 1, and a filtration rate of about 3 m.g.d., approximately one-third of the color was removed, but I understand that the filter had to be raked every four to five weeks to give the required rate of filtration. Another city plant in New England will shortly be changed from slow sand to mechanical filtration, I have been informed, because the beds will not filter sufficient water for local consumption.

Robert Spurr Weston, George A. Sampson and the writer decided several years ago that a solution of copper sulphate, sprayed over the water to be treated—as a pond, lake or reservoir—was much more liable to be thoroughly mixed and much less liable to kill fish by excess concentration of the chemical where locally applied than by the usual method of dragging copper sulphate in a burlap bag behind a boat.

I regret to learn that there are doctors and engineers who still object to mechanical filters because "dope" must be used with them. Probably this means aluminum sulphate. Chlorine was used on Hartford, Conn., water before slow sand filters were installed and the people must have become thoroughly accustomed to this kind of "dope" without any harmful effects. Chlorine is used in over 4,000 places throughout the United States at the present time, and both the typhoid death rate and the total death rate are lower than before chlorine was used.

The aluminum sulphate used with mechanical filters in well-operated New England plants, and many others, is removed and the filtered water has as little or less aluminum salts than the untreated water. As long ago as March, 1915, the Belfast, Me., reservoir water had 1.1 p.p.m. of aluminum salts Al_2O_3 and the filtered water 0.43 parts.

After working on many waters, industrial wastes and different kinds of sewage, it is the writer's belief that it is much cheaper, measured by work done compared with cost of doing it, to alum coagulate and mechanically filter colored waters than to store the water sufficiently long to kill bacteria and lower color, or to slow sand filter the water, or to spend as much money to improve the watershed. In purifying turbid waters chemical treatment alone or with mechanical filtration is the only method which has given satisfactory economical results. Chlorine still leads in low cost of pathogenic, sewage and harmless bacteria removal, measured by laboratory tests and lower death rates.

ARTHUR L. GAMMAGE.
Chief Chemist, Weston & Sampson.
Boston, Mass., Dec. 15, 1922.

Ironwood Long Lived in China

Sir—I notice in your issue of Oct. 12, 1922, a report by C. J. Embree on greenheart as a teredo resistant on the Panama locks. One of the authorities mentioned by Mr. Embree as having been consulted originally is "Timber" by J. R. Baterden, in which (p. 124) the author states authoritatively that greenheart is *not* proof against the teredo.

In view of this, and of the remarks on billian or ironwood (p. 196) which he states is "one of the few timbers practically impervious to the teredo," it seems somewhat surprising that the latter was not selected in preference to greenheart.

The experience with billian in this colony is that for underwater work it is unsurpassed, but, curiously enough, it is not proof against white ants. We have old military piers here, originally constructed entirely of billian. The piles show no signs of deterioraton, but the superstructure has had to be replaced by reinforced concrete.

C. W. DAVY,
Colonel, Chief Engineer, British Forces in China.
Hong Kong, Nov. 23, 1922.

The Railways and the Motor Truck

Sir—Your gentle criticism of Mr. Hirst and of the *Wall Street Journal* under the heading of "Much Heat but Little Light" in *Engineering News-Record* of Dec. 21, 1922, p. 1055, is admirable. It is to be regretted that Mr. Hirst did not confine his discussion to the fundamentals of highway department organization, with which subject he is familiar.

"Most of the railroad executives" are not at all alarmed about "the motor trucks and the motor buses making it impossible for them (the railroads) to operate at a profit." Such an effect is possible in certain isolated cases in Mr. Hirst's state, particularly and specifically where short and well-paved highways parallel a financially weak but exceptionally well managed railroad. But it is not a condition general throughout the country, as Mr. Hirst implies. In fact, there are many well informed persons who hold that motor trucks, motor buses and good roads are helps rather than hindrances to the railroad's earning power, in that they promote interchange of ideas and business which indirectly is of universal benefit.

In his condemnation of most of the railroad executives Mr. Hirst is sadly misinformed. If the board of directors of a railroad could appropriate a definite amount of money with the positive assurance that this amount would be forthcoming (as is Mr. Hirst's case) it is possible that they would show more activity. The wonder is not that the railroads can operate as well as they do, but that they can operate at all under their handicaps, restrictions and present and prospective legislation.

Mr. Hirst's problems at their most difficult stages are as nothing when compared to those of a railroad executive. If he had to raise the money he spends it is possible he would have a much clearer appreciation of the problems confronting the railroad executive. It is to be regretted that Mr. Hirst in his enthusiasm over his own particular life's work saw fit to attack the work of the highly efficient body of executives who manage the American railroads.

W. J. HOWARD,
Engineer, The Kelly-Atkinson Construction Co.
Chicago, Dec. 28.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Suspension Cable on Bridge at Kelso, Washington, Parts; From 12 to 15 Lives Are Lost

Failed at Point Near Where Cable, of 5 Strands of 1¾-In. and 1¼-In. Galvanized Material, Entered Anchorage

Special Correspondence

FROM 12 to 15 persons were drowned Jan. 3 when the five-strand upstream cable of a suspension bridge across the Cowlitz River at Kelso, Wash., parted at a point near where it entered the anchorage. The bridge was a timber structure with one 300-ft. suspension span and a 100-ft. double-leaf vertically-hinged span. Suspension cables ran from the west anchorages over three timber towers; one at the west end of the 300-ft. span and one each side of the channel. As the upstream cable failed, that side of the suspension span dropped to the river. A six-mile current caught the floor broadside and overturned the three towers, dropping the channel span into the water.

Four 2-in. galvanized cables supported the suspension span, there being two cables to each side. These cables, run from the west anchorages over the three towers, engaged four turnbuckles on the east end, two to each side of the bridge. The two turnbuckles on the side which failed were connected to the anchorage by five cables. Two of these were 1¾-in. material and looped through a ring sheath to one turnbuckle. The other three cables (one 1¾ in. and two 1¼ in.) looped through a similar ring sheath to the other turnbuckle. No equalizers were used. This tackle extended to the anchorage about 20 ft. into the ground.

All cables were galvanized but lacked other protection. The five cables parted at a point near where they entered the anchorage. As yet they have not been dug out to be examined. The portions of the cables below ground show marked deterioration. Above ground they are apparently in good condition.

The structure was built in 1905 for light loading. It was washed out the next year but replaced in 1907 and in 1915 it was partially retimbered. The original cables and anchorages remained. During the last six months the traffic had been increased many times over the original normal traffic by a large sawmill development in the vicinity. The bridge is a county structure not subject to state inspection or maintenance.

The state is building a concrete and steel bridge just downstream from the structure which failed.

Minneapolis Plans Large Addition to Water Supply

Minneapolis will begin work this spring on an addition to its water-works system that will add 40 m.g.d. to its daily capacity, will cost, as estimated, $2,673,360 and will require three years to complete. The Mississippi River will continue to be the source of supply. The present reservoirs and filter plant at Columbia Heights, just outside the city, provide a maximum of 62 m.g.d. The proposed project contemplates a pumping, storage and filtration unit on a 40-acre site owned by the city of Fridley. A report prepared by J. A. Jensen, supervisor of the water-works, contains these estimates of cost:

Intake, screen house and pump wells, complete, $181,860; low service pumping station, complete, $207,330; coagulation and mixing basins, 60-m.g. capacity, $506,700; twelve filters, 40-m.g.d. capacity, $489,600; clear water basin, 60-m.g.d. capacity, $222,830; force main, 48-in. pipe, $153,000; low service pumps and equipment, 75 m.g.d., $118,650; high service pumps and equipment, 75 m.g.d., $130,050.

According to N. W. Elsberg, city engineer, the capacity at the Fridley site eventually will be increased to 100 m.g.d. The water-works committee of the City Council has approved the Jensen report and steps are being taken for a preliminary bond issue to start construction.

In the last four years, the average daily consumption of water in Minneapolis has risen from 89 to 100 gal. per capita.

To Investigate R.R. Equipment

Acting on its own initiative the Interstate Commerce Commission has ordered an inquiry to determine whether the American railroads have adequate equipment of locomotives and cars and whether interchange practice is sufficiently developed.

Wage Conference in Coal Industry Adjourned to New York

The conference between the coal miners and operators which met at Chicago on Jan. 3 to fix wage scales for the bituminous field has adjourned without reaching any agreement. The conference included fifteen districts and in the opinion of some was too large and represented too many divergent opinions among the operators.

It is expected that a call for another meeting in New York between Jan. 17 and 22 will be issued shortly. This call, it is understood, will include the old central competitive field of Illinois, Indiana, Ohio and Western Pennsylvania, and possibly some additional districts. From present indications the issue to be settled at the new conference will be as to whether agreements shall be on the basis of individual districts or on the basis of the old central competitive field or some modification thereof.

Indianapolis A.A.E. to Attack Smoke Nuisance

The Indianapolis Chapter of the American Association of Engineers is mapping out a program covering two or three years by which it will try to abate the smoke nuisance in that city. A committee appointed by the mayor has been working for several months and steps have been taken to reduce the smoke created by some of the public buildings. The Board of Public Works now has several proposals to install equipment looking to this end, and if this should prove to be successful a number of business firms probably will follow suit. It is said about 90 per cent of the smoke nuisance is actually caused by the house furnace and studies are to be made toward development of a practicable method for application to them.

It is agreed that educational methods rather than force will bring about the most satisfactory results. A study is to be made of smoke abatement in other cities and an effort will be made to have the smoke inspection department manned by competent engineers, to check up installations and assist coal users. Purdue University will be asked to conduct a comprehensive coal consumption, smoke and soot survey of the city.

Harding Urges U. S. Join in Road Congress

In a recent message from President Harding to Congress there was included recommendation that the United States become officially represented in the Permanent Association of International Road Congresses. A part of the President's recommendation was that the Secretary of Agriculture be permitted to advance the necessary funds for membership out of an administrative fund provided by the Federal Highway Act of 1921.

"I believe it is altogether desirable," said the President, "for the United States to have representation in this association, and I strongly recommend the granting by Congress of the authority requested by the Secretary of Agriculture."

The State Department will be requested to place the matter before Congress with a favorable recommendation that the United States become a member of the organization.

Senate Passes Science Center Building Bill

The Senate has passed the Fernald resolution reported from the Public Buildings and Grounds Committee providing for a commission to consider the proposal of the American Arts and Industries Association, Inc., to erect in Washington, a $30,000,000 building as a national center for applied and industrial arts. The resolution now goes to the House for action. This will not be a government building but will be paid for by membership.

Engineers Take Part in Science Meeting in Boston

At the 76th meeting of the American Association for the Advancement of Science in Boston during the week of Dec. 26, engineering was represented by two sections, Section K, social and economic sciences, of which Dr. Henry S. Graves, of Yale Forest School, Yale University, is vice-president and chairman, and Section M, engineering, of which F. M. Feiker, vice-president of McGraw-Hill Co., Inc., New York, is vice-president and chairman.

The relation of the engineer to conservation was the keynote of the joint meeting of these two sections. John T. Black, state health commissioner of Connecticut, presented a paper on "Conservation and Industrial Waste," and William S. Murray, New York City, spoke on "The Conservation of Power." O. C. Merrill, secretary of the Federal Power Commission, Washington, D. C., was to have spoken on "The Federal Water Power Policy," and Brig.-Gen. Harry Taylor, Corps Engineers, Washington, D. C., was to have presented a paper on "Problems of Flood Control," but badly-delayed trains prevented them from doing so.

At the meeting of Section M the principal discussion was "The Place of the Engineer in Civilization." Dr. Ira N. Hollis, president of Worcester Polytechnic Institute, in his paper on this subject pointed out that from earliest history emphasis had been placed upon the man who produces and that the root names for *producer*, in several of the earlier languages, are synonymous with the modern definition of the term *engineer*. In an address on "The Growth of the Mining Industry in Canada," Dr. J. B. Tyrell, retiring vice-president of the section, pointed out the part that steam railway transportation plays in the development of the mining industry as one practical illustration of the engineer's place in utilizing our natural resources. Harrington Emerson emphasized the fact that the engineer is deeply concerned with civilization because of his control over the instruments of production and the need of his analytical study of facts for the solution of present-day problems. The paper, "New Phases of Engineering Education," by Prof. C. F. Scott, of Yale University, president of the Society for the Promotion of Engineering Education, was presented in Prof. Scott's absence by Dr. Dugald C. Jackson, and indicated that because engineering is coming to take such a large place in our modern life it is essential that the training of engineers be approached with a new viewpoint.

At the evening session an illustrated address on "Engineering and Scientific Developments of South America" was given by Calvin W. Rice, secretary of the A. S. M. E.

Brazilian Engineering Club Elects Americans Members

In a cablegram recently received advice is given to the effect that the Club de Engenharia of Rio de Janeiro, has elected Verne Leroy Havens, editor of *Ingeniería Internacional* an honorary member. Other honorary members are Edward Wegmann, Samuel M. Vauclain, and Calvin W. Rice. Josiah Spurr and Louis Hirt have been elected corresponding members.

Award N. Y. Transit Contracts for More Than Two Million

The New York Transit Commission has awarded three contracts for rapid transit construction which amount to $2,325,983. The Ft. Hamilton extension contract has been awarded to the T. A. Gillespie Co., on its bid of $1,485,151. The 14th St. extension went to Frederick L. Cranford, Inc., whose bid was $750,982. A contract for two additional elevators at the 168th St. Station of the West Side subway has been awarded to the Otis Elevator Co. for $89,850.

Syracuse Garbage Reduction Works Closed

The garbage-reduction plant of Syracuse, N. Y., was shut down on Dec. 10 and since then the garbage has been buried. The plant was built by the city and went into operation March 1, 1921. A change of city administration took place Jan. 1, 1922. The present administration states that for the ten months of operation in 1921 the plant was operated at an average loss (meaning net cost) of $8,000 a month and that this has been reduced by $1,000 a month since then. Proposals were invited a few months ago for the private operation of the plant. An offer of the rate of about $4,000 a month was received. Its adoption was advised by the mayor but was blocked by the city council.

Topographic Survey Appropriation Increased to $500,000

Washington Correspondence

In the face of strenuous objection from House leaders, the lower chamber of Congress, sitting as a committee of the whole, overrode the Appropriations committee and the Bureau of the Budget and voted to increase the appropriation for topographic surveys from $324,500 to $500,000. The fight for the increase was led by Representative Temple, of Pennsylvania.

Representative Mondell, the majority leader, predicted that the action of the Committee of the Whole would react adversely on appropriations in the future. He said the amendment provided more money than could be expended in an orderly and economical manner during the course of the next fiscal year.

C.N.R. Considers Electrification of Ontario Line

Sir Henry Thornton, president of the Canadian National Railways, announces that the C.N.R. board proposes to electrify or otherwise improve the service in the vicinity of Toronto and Hamilton from time to time as circumstances and the demands of the traffic justify. He states that "as a preliminary step, an examination of the services between Toronto and Hamilton and Niagara Falls and eastward from Toronto towards Cobourg will at once be put in hand with a view at least to partial electrification as soon as possible. Other developments will follow as may be required."

Fred T. Ley Company Sued on War Fraud Charge

Government Seeks to Recover $5,000,000, Alleging "Unconscionable Waste" in Devens Construction

Supplementing previous suits of a similar nature the U. S. Government on Jan. 3 instituted in Boston action against Fred T. Ley & Co., Inc., of Springfield, Mass., to recover $5,000,000 for alleged breach of contract in the construction of Camp Devens army cantonment. A writ of $8,000,000 was given the U. S. Marshal, but the declaration, which will not be officially filed until a return is made on the writ, will ask that $5,000,000 be returned. The writ is returnable on the third Tuesday in March, and some belief has been expressed in Boston to the effect that actual trial will not come before fall.

The charge is made by the government that the Ley company was guilty of "great and unconscionable waste" of materials in the cantonment construction work; that unskilled workmen were paid the same scale as that given skilled workers, and in many cases far in advance of the local scale for the same labor; that large amounts of unnecessary work were permitted to be done; and that "loafing" was permitted as well as "sabotage on the part of workmen and laborers."

It was stated in the declaration of the government that owing to the diversity of interest occupying the government at the time the construction was going on it was impossible for proper federal supervision to be given, and that as a result advantage of the situation was taken by the defendant.

The declaration further charges that the Ley company "counselled, advised, permitted and connived in the carrying out of the work in a grossly negligent and wasteful manner in utter disregard of the terms of the contract."

Dust Explosion Wrecks St. Louis Flour Mill

The Schreiber Cereal & Manufacturing Company's mill and elevator, Kansas City, Mo., were completely destroyed by fire on Dec. 27 following a dust blast. There was no loss of life but twenty of the forty employees were seriously injured. The building was a two-story, brick structure, constructed in 1905, 50 x 125 ft. in plan, with an iron-clad frame elevator in the rear five stories high. The force of the explosion blew several men from the elevator into the street 40 ft. below and large pieces of the sheet iron sides of the elevator were found 100 ft. away. Windows in adjacent buildings were shattered and considerable damage was done due to the force of explosion.

The cause of the explosion and fire is not definitely known but it was reported by the fire chief to have been started either by a spark from a locomotive which had backed cars into the elevator only a few moments previously, or to sparks from machinery within the building. A small fire had occurred on the day previous due to a dust fire said to have been caused by sparks from a motor in the mill. Following the first fire the assistant fire chief reported a dangerous accumulation of dust and an inspector was preparing to visit the mill when the explosion took place.

House Committee Seeks Light on Immigration Needs

Washington Correspondence

Hearings before the House committee on immigration, looking toward amendment of the present 3-per cent quota immigration law rather than framing of permanent immigration legislation, have made clear that representative industries are not seeking a lowering of the bars to admit a flood of aliens but rather what they consider would be improvements upon the present system with restrictions as to numbers, tempered to meet conditions along elastic lines.

Among witnesses who have been heard by the House committee in behalf of liberalizing amendments to the present temporary law have been a committee from the National Merchant Tailors' Association; E. B. Reid, assistant Washington representative of the National Farm Bureau Federation; James A. Emery, representing the National Association of Manufacturers; J. M. Larkin, assistant to the president, Bethlehem Steel Corporation; and M. H. Ward, representing the National Council of State Manufacturers Associations.

The witnesses all have agreed that immigration should be by selection. The manufacturers have asked an amendment which would make the incoming quotas net; that is, add to the quotas the number of aliens who leave the United States for their native lands. Representatives of the industries also urge that the Secretary of Labor be authorized to increase the quotas whenever it can be established to his satisfaction that a shortage of any kind or class of labor exists. It also has been proposed that immigration policy be administered by a board comprising the Secretaries of Labor, Commerce and Agriculture. Changes in the literacy tests also have been requested, it being contended that the present system does not accomplish its purpose. All witnesses have urged that examinations be at the port of embarkation rather than after arrival in the United States.

Chicago Sanitary District Budget $11,500,000 for 1923

Engineering work confronting the Sanitary District of Chicago during 1923 is outlined in a recent report of E. J. Kelley, chief engineer, to the trustees. Of work under contract the estimated expenditures will be $4,894,000. In order to complete eight projects under way additional contracts totaling $1,093,000 should be let early in the year.

During 1923 various new projects may be started, of which the $13,500,000 North Side treatment works and the $8,500,000 North Side intercepting sewer are the largest. Remodelling Lawrence Ave. pumping station at a cost of $500,000 is considered important and the regulation works at the outlet of Lake Erie and Lake Ontario may become urgent. The largest expenditures during 1923 are estimated as follows: North Side works, $5,000,000; North Side intercepter, $2,000,000; three bridges, $1,700,000; remodelling Lawrence Ave. station, $400,000. The ultimate total estimated expenditures for the projects named and twenty-one others is $77,811,500, of which $11,541,500 may be spent this year.

Hoover Declines Transfer from Commerce to Interior Post

Secretary Hoover has declined the invitation of the President to become Secretary of the Interior in the place of Secretary Fall who recently resigned that office. In a statement announcing this decision he recalls that when he accepted the office as Secretary of Commerce he did so with the intention of making that department an effective and helpful organization in the interest of American business. Although this work has been put in hand, it is not yet in a condition satisfactory to Secretary Hoover and until it is he does not wish to leave his present post.

Among the candidates for the office who have been discussed since Secretary Hoover's declination is John Hays Hammond, the mining engineer, now chairman of the President's Coal Commission, which is investigating the coal industry.

Indiana County Highway Engineers Under New Licensing Law

The first state-wide examination of applicants for license under the 1921 Indiana act for registration and examination of professional engineers and land surveyors, was held recently in the State House in Indianapolis. R. L. McCormick, a member of the faculty of Rose Polytechnic Institute, is chairman of the board. Twelve persons made application to take the examination.

U. S. Lesh, attorney-general of Indiana, has ruled that if a county surveyor in Indiana desires to perform the duties of a county highway engineer, he must obtain an engineer's license under the 1921 act. The head of the state tax board asks for a ruling on the question, which was raised in the case of a county-surveyor elect who is said to have no license under the 1921 act. Licenses are obtained only after passing regular examinations conducted by the board charged with administering the act.

Bolivian Government Will Build Railway Extension

Proposals for the completion of the Potosí-Sucre Railway in Bolivia have been rejected as unsatisfactory and it is reported that the Bolivian Government has decided to carry out the work instead of letting it by contract. The same course was followed in the construction of the present part of the line, the work being done under the direction of W. L. Milner, now general manager and chief engineer. This project was noted in *Engineering News-Record*, Aug. 31, 1922, p. 352.

Am.Soc.T.M. Annual Meeting Definitely Fixed

The executive committee of the American Society for Testing Materials has announced that the twenty-sixth meeting of the society will be held at Atlantic City, N. J., at the Chalfonte-Haddon Hall Hotel, beginning Monday, June 25, 1923, and ending either Friday or Saturday of that week, depending on the development of the program. No announcement has yet been made regarding the details of the meeting.

Army Report on Astoria Advises Filling Streets Only

With the sanction of President Harding, bills have been introduced in both the Senate and the House of Representatives which propose expenditures from the Federal Treasury to aid in filling in the area in Astoria swept by fire on Dec. 8. (See *Engineering News-Record*, Dec. 14, p. 1041.) The bill introduced by Senator McNary makes $500,000 available from an unexpended balance in the rivers and harbors fund which would be used for dredging the channel in front of the city and delivering the dredged material to the burned area.

The work to be done is covered in a report from Colonel T. M. Anderson, Sixteenth Infantry, U.S.A., as follows: "Restorative measures are beyond the power of municipality and state. The municipality is absolutely bankrupt through previous heavy issues of bonds for former street, municipal, and port terminals. Immediate relief work as follows is recommended: The construction by the United States Government of bulkheads for streets in the affected districts, the same to be filled by sand, dredged from the harbor along the Astoria waterfront which in places is in need of dredging. The restoration also of the sewer, water and electric systems. This latter work, as stated above, cannot be done by this bankrupt city and is absolutely necessary before the devastated district, which comprises all the business section of the city, can be reconstructed. The rehabilitation refers to municipal work only—street, water and sewerage systems—together with fire and police wiring. No portion is for property owned by private individuals. The estimated cost is $1,250,000."

In a more detailed report Major Richard Park, Engineer Corps, U.S.A., states: "The burned-over area is already filled to the basement floor level and street plans call for sand fill only between retaining walls under the curbs. It is unwise to fill the entire area to street level and then excavate for basements, which would call for retaining walls in any event, and the removal of sand when excavating basement. About 125,000 cu.yd. would be needed to fill under the streets and between the retaining walls, costing $25,000.

"Colonel Anderson's report estimating $1,250,000 as cost of retaining walls, fills, pavements, water and sewer systems rebuilt on this basis has been roughly checked by me and appears reasonable."

New York State Canals Report Heavy Tonnage for 1922

State Superintendent of Public Works Charles L. Cadle reports for 1922 the largest tonnage carried on the New York State Canal system in any year since 1913. The Erie Canal is credited with 1,485,259 tons, the Champlain Canal with 335,844 tons, the Cayuga-Seneca Canal with 42,592, the Oswego Canal with 9,470, the New York City Canal terminals with 76,519, and the Buffalo Canal terminals with 38,451 tons.

The Erie Canal traffic between Troy and Buffalo showed an increase of 50 per cent over that of 1921.

Engineering Societies

Calendar

Annual Meetings

FEDERATED AMERICAN ENGINEERING SOCIETIES, Washington, D. C.; Annual meeting Washington, Jan. 11-12.

AMERICAN ROADBUILDERS ASSOCIATION, New York City; Annual Convention, Chicago, Jan. 15-18.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Annual meeting, New York City, Jan. 17-19.

AMERICAN CONCRETE INSTITUTE, Detroit; Annual Convention, Cincinnati, Jan. 22-26.

ASSOCIATED GENERAL CONTRACTORS OF AMERICA, Washington, D. C.; Annual meeting Los Angeles, Jan. 30-Feb. 3.

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago, Annual Convention, Chicago, March 13-15.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago; Annual Convention, Norfolk, Va., May 7-9.

The Harvard Engineering Society will hold its annual dinner in New York, Feb. 1, at the Harvard Club. President C. R. Richards, of Lehigh University, Dr. Charles P. Berkey, Columbia University, and Albert Palmer, president of the undergraduate section of the society, will be principal speakers.

Personal Notes

L. H. BOND, district engineer of northern lines, Illinois Central R.R., has been appointed assistant engineer of maintenance-of-way, with headquarters at Chicago, succeeding W. G. ARN, promoted to assistant chief engineer of Chicago terminal improvements. M. M. BACKUS, district engineer of western lines, succeeds Mr. Bond as district engineer of northern lines, with headquarters at Chicago.

F. C. SHENEHON, consulting engineer of the firm of Shenehon & Meyer, Minneapolis, Minn., has been appointed vice-president and general manager of construction and engineering of the Byllesby Engineering & Management Corp. In addition to numerous engagements on federal water power and Great Lakes problems, he served eight years as dean of the college of engineering at the University of Minnesota. As consultant for the Sanitary District of Chicago, he studied the regulation of lake levels by proposed controlling works in the Niagara and St. Lawrence Rivers. Mr. Shenehon will move to Chicago.

J. E. FANNING, roadmaster of the Iowa division, Illinois Central R.R., has been appointed district engineer of western lines, with offices at Waterloo, Iowa, to succeed M. M. Backus, who has been promoted. N. R. HILL succeeds Mr. Fanning as roadmaster, with offices at Fort Dodge, Iowa.

OTTO E. OSTHOFF, vice-president and chief engineer, H. M. Byllesby & Co., Chicago, has resigned. Mr. Osthoff is one of the original members of the company.

GORDON L. SHANKS has recently been appointed chief draftsman in charge of design on a large oil refinery extension program for the Royal Dutch-Shell Oil Co. at Nood River, Illinois. Mr. Shanks spent a year recently in Tampico, Mexico, on similar work for the same company.

CHARLES S. BILYEU, formerly assistant to the president, Gulick-Henderson Co., consulting and inspecting engineers, has resigned that position and has joined the construction department of Sanderson & Porter, engineers, in the New York Office.

J. R. VERNON, assistant division engineer for the Wisconsin Highway Commission, has resigned, and has accepted a position with the Johnson Service Co., engineers and contractors of temperature regulation and humidity control systems, Chicago, Ill.

FRANK WILLIAMS, for four years state engineer of New York and as such a member of the New York Tunnel Commission, his term expiring Jan. 1, has been elected by the New York and New Jersey Tunnel Commissions a member of the board of consulting engineers for the Hudson River vehicular tunnel.

E. L. SAUVE, Fullerton, Neb., has resigned his position as labor superintendent for the Laurentide Co., Grand Merle, P. Q., and is now construction superintendent with the Fargo Engineering Co., consulting engineers.

THE TECHNICAL ADVISORY CORP. has been retained by the McDonald Construction Co. of New York to assist in organizing its forces for the purpose of constructing a joint system of state, county and municipal roads in the vicinity of Tampa, Fla. Marshall W. Brown, formerly lieutenant-colonel of engineers, A. E. F., is actively engaged in the work of organization and will be in Florida about two months.

H. A. DIXON, chief engineer, Western Lines, Canadian National Ry., Winnipeg, has been appointed chief engineer, Canadian Northern Pacific Lines. T. H. WHITE, formerly chief engineer, Canadian Northern Pacific Lines, Vancouver, B. C., has been appointed consulting engineer.

S. R. LAMB, resident engineer McLennan, Alberta, has been nominated engineer of maintenance-of-way of the Edmonton, Dunwegan & British Columbia Ry. I. S. REID, chief engineer of the road, has resigned.

W. L. CORTON, chief engineer with the public utilities commission at Boise, Idaho, has resigned. His resignation became effective Jan. 1.

W. M. JONES, formerly with Dwight P. Robinson & Co. and the J. G. White Engineering Corp., and now of the firm of Jones and Beardslee, architects and engineers, Bergenfield, N. J., has been appointed engineer for that borough for the year of 1923.

C. M. BABCOCK, state highway commissioner, Minnesota, is seeking a $20,000,000 bond issue of the legislature now in session, the proceeds to be used in hard-surfacing state highways, one-half to be expended this year and the other half in 1924. He holds that paving roads now where traffic is heavy will prove wise economy and points out that the proposed bond issue, instead of increasing taxes, would merely anticipate receipts from motor vehicle taxes, which would be expected to pay interest and principal eventually.

C. I. FELPS formerly division engineer of the Kansas Highway Department, has been appointed assistant state highway engineer in charge of road and bridge work. F. W. EPPS formerly bridge engineer has been appointed division engineer to fill the vacancy created by Mr. Felps's advance.

R. C. HAM, formerly county engineer of Ford County, Kansas has resigned to accept a position as county engineer of Jefferson County, Kansas.

J. E. STEARNS, formerly city recorder, has been appointed city manager of La Grande, Ore., to take the place of A. A. KRATZ, who has resigned to take up the practice of civil engineering.

A. W. SANBORN, who has been deputy surveyor general of California for the past 17 years, has resigned and will take up his residence in Los Angeles.

R. M. SMITH, former assistant city engineer of Kenosha, Wis., has been appointed city engineer. P. J. HINTGEN, former city engineer, has been promoted to director of public works.

ACME ENGINEERING CO., Waukesha, Wis., has been incorporated to carry on a general engineering business. Fred H. Grohl, formerly with the Universal Engineering Co., Eau Claire, is president. A. C. Nickel, vice-president, and G. H. Nickel, formerly division engineer of the Wisconsin Highway Commission, is secretary-treasurer.

FRANZ & BOND, architects and engineers, 189 High St., Holyoke, Mass., have dissolved partnership due to the appointment of Philip H. Bond as city engineer. Fred H. Franz will carry on the business at the same address.

JOHN DUFF, county engineer, has been appointed construction and maintenance engineer of Chelan County, Wash.

ALFRED J. T. TAYLOR, formerly head of the Taylor Engineering Co. of Vancouver, B. C., has been appointed vice-president and managing director of the Combustion Engineering Co., Ltd., of Toronto.

WILLIAM CHISHOLM, of Antigonish, N. S., has been appointed minister of highways for Nova Scotia, succeeding H. H. Wickwire, who recently died.

M. J. RUTLEDGE, formerly with Henry Holgate, consulting engineer of Montreal, has been appointed town manager of Woodstock, N. B.

R. M. MURRAY, consulting civil engineer, has opened an office at 326 Hutton Bldg., Spokane, Wash., and will specialize in bridge and structural engineering.

From the Manufacturer's Point of View

A Point of Contact
Between Maker and User of
Construction Equipment and Materials

Review of Construction Equipment and Materials During 1922—Part II

DEVELOPMENTS in construction equipment and materials during 1922, as noted in "Engineering News-Record's" review beginning in last week's issue, took the form of improvements in details rather than in new types of machines. The opening installment of the review included power shovels, concrete chuting equipment, industrial locomotives, elevating loaders and rock crushers. This week additional classes of equipment are covered.

Road Grading Equipment

A NEW feature of road-grader equipment introduced last year provided for varying the width of the blade by means of hinged wings at each end. These wings, 3ft. long, may be extended in line with the blade for full-width cuts, folded all the way back for narrow cuts, or set at right angles to the face of the blade to form a wheeled scraper. Another innovation was the use of sectional grader blades in three pieces with hinged joints to make the cut conform to the crown of the road.

A number of scarifier attachments for use on graders and rollers were produced. In the case of attachments to road rollers pneumatic and steam control devices were developed, while in the case of attachments to graders the designs cause the scarifier to be raised and lowered with the blade. One manufacturer altered the design of its subgrader to produce the new cross-section required by revised road specifications in Illinois.

In addition to the blade graders proper, several new types of tractor-operated road drag, under names such as pressure planes, were put on the market. A gas engine subgrade road roller weighing only 3 tons was among the year's offerings.

Austin Manufacturing Co.

FOR BLADE graders an attachment, known as the double-ender, was designed for lengthening the blade 3 ft. on each end. It consists of hinged wings which may be folded back for a narrow cut, extended straight out for maximum width, or set at an angle of 90 deg. with the blade thus converting the equipment into a wheeled scraper for moving dirt to fill holes.

Scarifier attachments, pneumatically operated when used with road rollers and attached directly to the blade when employed on a grader, were perfected during the year. In addition, a pressure road plane for maintenance work, designed for operation with a tractor, was developed. It is of all-metal construction with long runners which prevent the plane from dropping into low spots in the road. Another feature is the provision made for transferring a portion of the weight of the tractor to the runners. Hand levers adjust both front and rear blades.

Subjects Covered by Review

Last Week

Power Shovels
Concrete Chuting Equipment
Industrial Locomotives
Elevating Loaders
Rock Crushers

This Week

Road Grading Equipment
Concrete Mixers
Concrete Road Building Plant

Next Week

Cranes, Buckets, Hoists, etc.

Specifications for concrete roads by the Illinois State Highway Department resulted in the development of a light three-wheeled motor roller weighing only 3 tons, claimed to be the first of its kind on the market. This machine is intended to serve not only as a subgrade roller but also as a maintenance outfit, for which attachments of blades and scarifiers are furnished.

For its Little Western grader the Austin company has developed a scarifier attachment which is fixed to the circle; it may be raised or lowered with the blade to vary the depth of cut.

The Austin single-cylinder, 10-ton motor roller is now equipped with a self-starter. During the year improvements were made to eliminate vibration from motor rollers so as to make them acceptable for compacting hot material.

Avery Co.

ON ITS road "razer" the Avery Co. used a grading blade built in three sections, two 5-ft. lengths and one 2½-ft. length, overlapping and hinged at the joints to make the cut conform to the crown of the road. The blade may be

(Continued on p. 93)

More Suggestions—

For Better Equipment and Repair Parts Service

IN THE Dec. 14 issue was begun a discussion of "Better Equipment Maintenance and Repair Parts Service." Its object is to show how some of the misunderstandings between maker and user of construction machinery can be avoided. This week's contribution is a recital of experiences by manufacturers of steam shovels and cranes:

From a Maker of Cranes, Hoists and Excavating Machinery

IN SUPPLYING repair parts for construction equipment the following difficulty sometimes arises:

Users of our machines sometimes rent them to other contractors in different towns and the contractor who rents the machine frequently has occasion to send in for repair parts. In doing this he does not give the number of the machine, nor does he give the number of the part, which is very confusing. Furthermore, he signs his own name to telegrams ordering the renewal parts without giving the machine number. We are, therefore, at a loss as to who the owner of the machine is and his credit rating.

Another source of trouble is that the foreman on a job frequently signs his own name to a wire ordering repair parts, giving no further information, and we are absolutely at a loss to know what machine repair parts are wanted.

From the Marion Steam Shovel Co., Marion, Ohio

WE welcome the opportunity you have given us to enumerate briefly some of the shortcomings of our customers in the matter of ordering spare and replacement parts, which react to their own disadvantage in securing prompt and efficient service.

Every day we receive orders with the factory or serial number of the machine omitted. Our records are maintained according to these serial numbers and in cases where a customer owns several machines it is necessary for us to hold the order and write or wire for the information lacking. Through the medium of our repair lists and correspondence we constantly emphasize the importance of giving the factory number of machine with each order, but this item is too often overlooked.

We also ask the customer to be specific as to the description, casting number and shipping instructions. For instance, a customer just wired today: "Express at once follower plate for 300 engines." We assume that a piston follower head is wanted, but as there are three different types of engines

used on the machine we cannot fill the order until we get a reply to our message asking for the specific information that was lacking in the first telegram. Instances, of which this one is typical, are repeated each day.

Occasionally we receive a wire order signed by some unknown individual and not giving the firm name from which proper identification can be established. It is always embarrassing both to the user and ourselves when it is later found that the individual proves to be an official of a highly rated company. If orders were always signed with the company's name first and then the individual many troublesome annoyances would be eliminated and unnecessary delays avoided.

Don't make your telegrams too brief. State clearly what you want and see that casting numbers are correct.

Don't overlook shipping instructions. Say "freight," "express" or "parcel post" and give destination.

Don't order special fittings and expect immediate shipment.

Don't fail to take up COD shipments. It helps you to get material on open account later on.

Don't make a practice of waiting until you are down before ordering replacements. Accidents will happen but try to anticipate your requirements for wearing parts in advance thus having them on hand when needed.

Don't send us a wire order on Saturday afternoon and afterwards complain because the shipment did not get away until Monday. Most firms do not have regular operation on Sunday.

Don't criticize us too harshly if an occasional mistake is made by us. We are human too.

To sum up the whole situation we append a list of "Don't" for the benefit of those who are inclined to neglect the seemingly little details which contribute so largely to first class repair service.

The discussion will be continued in next week's issue.

You are invited to participate in it.

Gypsum Industries Association Dissolved by Court Order

In a decree signed last week by Judge Knox of the Federal District Court, New York, the Gypsum Industries Association was ordered dissolved as a combination in restraint of trade. The decree, according to Col. William Hayward, U. S. Attorney, who conducted the case for the federal government, is of far-reaching importance because, for the first time in the history of the Sherman law, there is set forth a code of principles governing trade associations. The decree prohibits agreement to: fix or establish prices; establish or maintain uniform prices; advance or decrease prices; limit, curtail or otherwise control production; fix boundaries of sales open only to certain members; and effect any discrimination in prices.

Further details appear in "The Business Side of Construction," p. 97.

Review of Construction Equipment and Materials During 1922

(Continued from p. 92)

raised by a power-lift device. The outfit is mounted on three wheels to minimize turning space.

Buffalo-Springfield Roller Co. A NEW model of three-wheel motor roller was announced during the year. The power unit is a horizontal two-cylinder opposed type gasoline engine, which, it is claimed, eliminates vibration and provides for the steady rolling desirable in laying asphalt and other bituminous pavements. The machine may be equipped with a pneumatically controlled pressure scarifier.

Lakewood Engineering Co. TO MEET the requirements of the new subgrade design specified by the Illinois highway department a subgrader in a new model was developed with an all-steel frame. A jack lever enables the machine to be raised on a turntable.

Stroud & Co. A WORM-GEAR device was installed on the Stroud elevating grader to raise and lower the carrier. Other improvements included a new lubricating system and a cast steel front bolster. To run the belt on the elevating grader an auxiliary gasoline engine was installed.

Western Wheeled Scraper Co. FOR ATTACHMENT to its standard grader a scarifier was developed which rotates and is raised and lowered with the blade, always remaining parallel thereto. When not desired for use the scarifier may be raised, thus allowing the blade to do its regular work. For road maintenance the points of the scarifier may be allowed to project 2 in. below the blade to loosen the material and facilitate the work of the blade.

Concrete Mixers

CONCRETE-mixer types divide naturally into two classes, one, the large-capacity, heavy pavers, and the other the smaller building and general construction mixers.

In the design of the large pavers the trend has been toward the production of self-contained units with power operated accessories in the form of charging skips, derricks for handling batch boxes, boom-and-bucket or chute delivery systems. As in the power-shovel field, there has been an increasing use of crawler traction mounting, while a comparatively new trend is seen in the rapidly increasing employment of rubber tires on wheel-mounted machines. This practice is more noticeable in the small and medium sized units, particularly those which must be moved frequently from one job to another. This year's design has developed several safety features, among them a double cable on the charging skip to forestall accident in case of the breakage of one cable and a skip guard to prevent injury to workers during the lowering or raising of the skip. The use of multiple-cylinder gasoline engines, instead of steam, for power has shown an increase.

A survey of developments in the building and general construction type of mixer, as distinguished from the paver, indicates that more stress is being placed upon mobility. Mixers are being mounted on Ford trucks and the use of both solid and pneumatic tire mountings has scored a big increase during the year. This holds true not only for the medium sized units, but also on the small types in which rubber-tired trailer mountings are now standard equipment. On building mixers, also, two-cylinder gasoline engines are being used more extensively on the grounds that they create less vibration than the one-cylinder engines. Four-cylinder gasoline engines are also favored. Many other detailed improvements.

American Cement Machine Co. RUBBER-TIRED WHEELS are being used for equipping a part of the line of concrete mixers manufactured by the American Cement Machine Co. In the case of the Packard tilter mixer and the Boss highway special mixer cord tires are used so that these machines may be hitched to the back of a motor truck and moved quickly from one job to another. Tire replacement can be made with standard Ford tires.

Chain-Belt Co. THE USE of concrete mixers equipped with rubber tires, the Chain Belt Co. has found, is becoming increasingly popular. The company cites the case of seven Rex mixers operated by the city of Milwaukee and a Rex paver purchased by the Milwaukee Railway & Light Co., both equipped with rubber-tired wheels.

Koehring Co. ON ITS 34-CU.FT. PAVER, a self-contained unit with multiplane traction, power charging skip and delivery boom and bucket, the Koehring Co. has introduced, for purposes of safety, a double cable on the skip and has equipped the unit with a power-operated derrick for transferring batch boxes from industrial railway cars to the skip of the paver, where an automatic arrangement dumps them from the bottom without tipping the boxes. In the upper part of the charging skip a curved steel plate has been placed to prevent damage from batch boxes bumping against it during discharge. To accommodate all methods of loading by truck and industrial railway the skip

has been widened and made a trifle larger than formerly.

The pavers are equipped with solid rubber tires when called for to facilitate moving over city streets without injury to the pavement or the mixer. Rubber-tired mountings are also supplied for the company's construction mixers for towing behind motor trucks. The construction mixers are built in what are known as right and left side types, so that when used in a battery of two the control levers are close together and may be operated by one man stationed between the machines.

Jaeger Machine Co.

A LIGHT-WEIGHT trailer mixer in two types, two-wheel and four-wheel, equipped with pneumatic tires, was announced by the Jaeger company. Mobility is the chief feature of these units. When ready to move it is merely necessary to attach the trailer to a truck or automobile and, with the rubber-tire equipment, speeds of 20 to 30 miles an hour can be made with safety.

Lakewood Engineering Co.

IN THE POWER equipment for concrete pavers the Lakewood Engineering Co. has observed an increasing tendency toward the use of multiple-cylinder gasoline engines instead of steam engines. Among improved features of its equipment are the use of replaceable bronze bushings for bearings, stronger and simpler clutches, and the use of two simple valves instead of the usually troublesome three-way water valve.

In the case of building mixers (from ½- to 2-yd. capacity) four-cylinder gasoline engines have in many instances been substituted for steam engines and boilers and lubrication has been improved by the application of the Alemite system.

On the small mixers (one bag and less) the use of rubber tires and spring suspension for increasing the mobility of the unit has been one of the features of the year. On these small mixers, also, the two-cylinder gas engine is being employed to reduce vibration caused by the single-cylinder power unit. The Lakewood company has found the two-cylinder engine more satisfactory in operation than the single-cylinder engine.

T. L. Smith Co.

THE NEW Smith pavers during the year were equipped with full-length traction and, in the case of gasoline-engine-operated units, with a new type of heavy duty Wisconsin four-cylinder engine. On machines with boom-and-bucket discharge a new type of cross-dump, large-capacity bucket was introduced. On the non-tilting drum type the manufacturers offered rubber-tired wheels in addition to the standard wheels.

Concrete Road-Building Plant and Equipment

DEVICES for measuring, storing and loading sand and stone aggregate for concrete from overhead bins into motor trucks or industrial cars are now available and there is in course of development complementary equipment for handling and loading cement. More extensive use of mechanical subgrading and finishing machines operating along steel forms for concrete roads has led to use of metal of increased thickness in the forms — ⅜ in. has been adopted by several manufacturers. To eliminate lost time in haulage and also to protect the subgrade several types of turntable for motor trucks have been brought out, one of them occupying only one-half the width of the subgrade and revolving over the side form. During the year manufacturers improved some of the details of finishing machines and designed a hand-operated belt float and bridge. A new type of premolded bituminous-felt joint was announced differing from former straight-faced types in a tongue and groove feature.

Austin Machinery Corp.

A BATCH distributor for concrete road work was developed to travel on the forms, spread the concrete the full width of the slab and strike it off. The device consists of a trough mounted on a carriage driven by a gas engine. The trough is charged directly from the concrete mixer spout and travels to the point where the concrete is to be discharged.

Blaw-Knox Co.

IN ITS Batcher plant the Blaw-Knox Co. has produced a combination elevated storage bin with adjustable measuring batchers which enable the contractor to store, accurately measure, and discharge by gravity predetermined batches of sand and stone into trucks or industrial cars. For charging materials, but not for storage, a smaller type of bin is supplied with a single batch-measuring device; ordinarily two of these charging units are employed, one for sand and one for stone.

To supplement the foregoing equipment for sand and stone the Blaw-Knox Co. is developing a handling and loading device for cement. It involves overhead steel batchers or hoppers dumping directly into box-shaped truck partitions. With the arrangement proposed the handling of cement at the paving mixer will be eliminated.

Improvements in steel road forms consisted mainly in strengthening and stiffening these units, particularly at the lock joint. A heavy form, known as the Dreadnaught, made of ⅜-in. steel was placed on the market during the year.

A turntable for motor trucks on road work was designed to rotate over the road form and to occupy only one-half the width of the subgrade, leaving space for the movement of vehicles alongside.

Philip Carey Co.

TO FORM a tongue-and-groove connection between concrete road slabs the Philip Carey Co. designed a new form of Elastite premolded bituminous-felt joint. It differs from the previous straight-faced types in having a trough-shaped projection, through holes in which stakes are passed and driven into the subgrade to hold the joint vertical during concreting. Advantages claimed for this joint are that it prevents spalling and crushing of concrete at the joint due to slab movement, forms a watertight seal, and preserves surface alignment by its interlocking feature.

Dunn Road Mach. Co.

SEVERAL simultaneous operations are performed by the Dunn finishing machine for concrete roads. It is a gasoline-operated carriage traveling on the forms with auxiliary strike-off which pushes surplus material ahead and smoothes the slab. Behind is the main strike-off or camber with a slow vertical movement to press down surface stone. Behind the camber are a spader and finishing belt. The action of the machine results in filling surface and interior voids, pressing out water, and smoothing the surface of the slab.

A. W. French & Co.

THIS organization put on the market the concrete road surfacer developed last year by William Ord. The device carries two heavy strike-off girders which use the tops of the forms as guides. The girders work back and forth across the road as the machine advances, producing a kneading action to remove excess air and water and produce concrete of maximum density.

Heltzel Steel Form & Iron Co.

MAINTAINING that steel forms for road construction should be of at least No. 9 gage and preferably No. 7 gage metal, the Heltzel company last year used a ⅜-in. thickness of open-hearth steel. This type of form consists of two units, independent pedestals, and rail forms hung from them. To provide large bearing area a 6-in. pedestal base is standard. Flat stakes are preferred to round bars for holding the pedestals in place.

(To be continued next week)

Business Notes

FOUNDATION CO., New York, has received from its stockholders approval of a new issue of 10,000 shares of no par value, cumulative convertible 7 per cent preferred stock, which is being offered to common stockholders on the basis of one new share of preferred for each four shares of common now held.

A. R. ULBRICH, formerly sales manager of the Terry Manufacturing Co., Inc., was appointed sales manager of the National Hoisting Engine Co. of Harrison, N. J. He assumed his new duties Jan. 1.

W. W. SCOTT, JR., was elected vice-president, Laclede Steel Co., St. Louis, Mo., effective Jan. 1. His first experience in the steel business was gained in the Homestead Works of Carnegie Steel Co., in the open hearth furnace department, after which he filled various mill positions before becoming connected with the sales department of the Carnegie company in Pittsburgh.

In 1919 he was made manager of sales, Carnegie Steel Co., Tennessee Coal, Iron & Railroad Co. and Illinois Steel Co., with headquarters in St. Louis. Early in 1922 he was appointed general manager of sales of the Laclede company.

WARREN C. NIXON, secretary of the National Association of Railroad Tie Producers, and vice-president of the Western Tie & Timber Co., St. Louis, Mo., died at St. Louis on Jan. 2.

The KELLY-SPRINGFIELD MOTOR TRUCK CO., Springfield, Ohio, has been placed in the hands of a receiver on application of the Bankers Trust Co., of New York. Pearl A. Lewis was named receiver by the court and was authorized to borrow $250,000 to continue the operation of the plant.

AMERICAN CONCRETE PIPE ASSOCIATION will meet Jan. 18, 19 and 20 at the Hotel Sherman, Chicago. A special session Jan. 19 to which practising engineers are invited will be addressed by Dean Anson Marston, Iowa State College; Langdon Pearse, Sanitary District of Chicago; A. M. Hirsh, Lock Joint Pipe Co.; S. H. McCrory, chief, department of agricultural engineering, U. S. Department of Agriculture.

METAL & THERMIT CORP., New York, announces that its Jersey City welding shop, in addition to present facilities for Thermit welding repairs, has been recently equipped for making welds on lighter sections by means of the oxy-acetylene and electric processes. This service is designed for large production work. The policy of equipping welding shops with the additional welding facilities noted above, will be extended to the other welding plants of the company.

Equipment and Materials

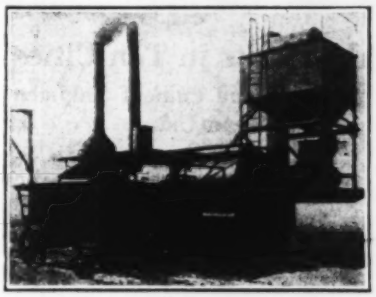
Asphalt Plant Has Three-Drum Sand Dryer Handling 120 Tons

A number of new features are included in the asphalt plant just announced by the Austin Machinery Corp., Toledo, Ohio. It is a portable unit consisting of three parts, the dryer and power plant, and two asphalt kettles. the equipment is the result of a year's test of a plant at Topeka, Kan. The plant has a capacity of from 1,000 to 1,400 sq.yd. of 2-in. asphalt top per 8-hour day.

The sand dryer will handle 120 tons of sand at 350 deg. F., to contain not more than 2 per cent moisture. The dryer embodies one of the particular features of the plant. Three drums are built into a unit, equal to a single continuous drum 4 ft. 3 in. in diameter by 40 ft. 8 in. long, giving the material an area of 438 sq.ft. of heating surface. This amount multiplied by 8 r.p.m. and the total by 4 min., the time required for the material to travel through the drums, gives an area of 12,912 sq.ft. with which it must come in contact. Thus, the highest temperature required is secured at a low fuel cost.

The kettles have a total capacity of 2,500 gal. They are heated by steam through jointless coils. This construction prevents damage to the asphalt and is superior to kettles heated by open fire.

The pug mill of 1,000 lb. capacity is chain-driven and discharges through a sliding gate in the bottom. Extra large



steam jacketed steam piping is used throughout. Air is employed to agitate the asphalt. The hot sand bin is of three compartments with a capacity of 10 tons.

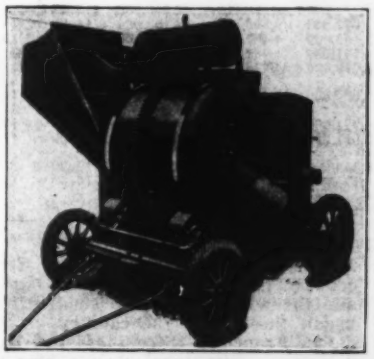
Steel Road Forms Strengthened

While preserving the basic principles of its steel forms for concrete road construction, the Blaw-Knox Co., Pittsburgh, has made certain improvements in this line of its construction equipment. The lock-joint plate connection between adjacent forms has been strengthened by increasing its weight and thickness, together with heavier riveting. The connection by which the form is staked to the ground and locked with a key or wedge has been improved by using one piece of heavier ⅜-in. plate. The wedge or key has been made longer and heavier and is now provided with a hole in the small end for a cotter key or wire, thus making the wedge integral with the stake track.

The company also has placed on the market recently a heavier type of road form known as the Dreadnaught, which is made of ⅜-in. extra heavy plate. This change is occasioned by the increasing use, by contractors, of heavier finishing machines and sub-grading machines traveling on the steel forms.

More Concrete Mixers Equipped With Rubber Tires

Rubber-tired wheels are being used by the American Cement Machine Co., Inc., Keokuk, Ia., for equipping part of its line of concrete mixers. In the case of the Packard tilter mixer and the



Boss highway special mixer cord tires are used so that this equipment may be hitched to the back of a motor truck and moved quickly from one job to another. The company points out that until recently small mixers were generally moved at slow speeds by horses. When hauled by trucks moving at 15 or 20 miles per hour mixers equipped with small wheels and steel tires are subjected to a great deal of jolting and rattling that works bolts loose, causes parts to work out of alignment, damages the engine, and results generally in breakdowns and delays.

On the Boss type of mixer 30-in. wheels with pneumatic tires are now used not only to eliminate damage to the machine itself during moves, but also to protect city pavements. The one-bag Boss mixer is now furnished with four-wheel trucks equipped with cord tires and the Packard tilting mixer is mounted on two-wheel Ford trailer trucks, also fitted with rubber tires.

During the operation of the mixer blocks can be placed under the axles to take the load off the tires. Tire replacement can be made with either new or used Ford standard tires.

Publications from the Construction Industry

Portland Cement Stucco—PORTLAND CEMENT ASSOCIATION, Chicago, has issued a 50-p. illustrated booklet on uses of portland cement stucco for architects and builders. In addition to many photographic illustrations of stucco-finished residences and of various types of finishes possible with stucco, it contains instructions recommended for use in the application of this material and drawings of typical construction details for stucco coverings on various types of buildings.

Centrifugal Pumps—DAYTON-DOWD CO., Quincy, Ill., in a new 32-p. illustrated bulletin, features its single-stage double-suction centrifugal pumps, (Type CS.) In addition to detailed specifications, there are given tables of speed, capacity and approximate efficiencies for various sizes of pump, and a table of dimensions. There are also a series of characteristic curves plotted from tests under various conditions. One section of the text is devoted to types of drive, including electric motors, steam turbines, gasoline engines and belted connections. A number of illustrations are given showing the adaptability of centrifugal pumps to various classes of pumping service and diagrams indicate correct and incorrect methods of installing suction lines.

Rustproofing for Iron and Steel—THE PYRENE MANUFACTURING CO., Newark, N. J., has issued pamphlets explaining the Parker process of rustproofing for iron and steel. The process, invented by Thomas Watts Coslett, an English chemist, in 1907, and developed in America by the Parker Co., of Detroit, consists in dipping sheet iron or other articles into a tank filled with a dilute solution of iron phosphate, heated nearly to the boiling point by steam pipes. By this treatment the iron, to a depth depending upon the density of articles processed, is converted into a basic iron phosphate. No high heat is required as in the Sherardizing and the Bower-Barff processes.

Business Side of Construction

Facts and Events that Affect Cost and Volume

Production and Materials Stocks in Ten Cities

Steel Output Increased—Gains in Lumber and Cement Shipments —Winter Brick Supply Lower Than Usual

Steel—A conservative estimate of the steel ingot output in the United States for 1922 would place the tonnage at somewhat over 30,000,000, or nearly double the production record of 1921. The output during the last year has been over 2,000,000 tons each month, since February and the new year starts in with an increased production rate and expansion in demand. The heaviest tonnages for first quarter delivery, have been placed by automobile manufacturers and railroads.

Lumber—An average of 388 mills reporting weekly to the National Lumber Manufacturers' Association, for the four weeks ending Dec. 23, show 794,197,310 ft. cut; 839,332,916 ft. shipped and orders covering 840,166,800 ft. b.m. These totals show a gain of 6 per cent in shipments but declines amounting to 17 per cent in production and 4 per cent in orders, during the month. According to the National Lumber Trade Barometer, Dec. 29, 1922, production stood at about 20 per cent; order 6 per cent and shipments 7½ per cent below normal.

Cement—Shipments for the entire country, during 1922, eclipsed all-previous records with an estimated total between 116,000,000 and 121,000,000 bbl. Estimated production figures approach the 117,000,000 mark for the year, with current stocks at about 5,000,000 bbl., or 40 per cent under the amount on hand one year ago.

Brick—Information as of Dec. 1, received from 97 companies reporting to the Common Brick Manufacturers' Association of America and who represent about 70 per cent of the production capacity of the country, shows about 94,000,000 brick burned and 80.000,000 shipped during the month. This represents an increase of 2½ per cent in the number of burned brick on hand. Fully 25 per cent of the brick plants of the country are closed down until spring and the winter supply is smaller than usual, throughout the country.

San Francisco—Stocks of steel bars, hollow tile, structural shapes, blue annealed and black steel sheets, manila rope and cut nails in very good condition. Fair supplies of track materials, sewer pipe, metal lath, lime, steel mesh, brick and lumber; and large quantities of road oils, asphalt and galvanized steel sheets available. Stocks low, however, on cement, structural rivets and wire nails.

Denver—Dealers' stocks in good shape as far as construction materials are concerned. Plenty of freight cars available since completion of fruit crop movement.

Minneapolis—Lumber stocks, while depleted as usual at this time, are nearly normal for the season. Dealers report that approximately 75 per cent of the winter's buying of lumber has been done. Stocks of common and face brick and hollow tile are reported below normal, with little or no accumulation in warehouses or yards due to the keeping up of demand resulting from continued mild weather throughout December. Some cement on hand but not much.

Detroit—Ample supply of sewer pipe for present needs, demand slightly decreased. Plenty of cement in storage at nearby Michigan plants. Only one cement mill closed down. Lime available from local and also Ohio, kilns. Plenty of brick but only a moderate supply of hollow tile on hand. Sufficient dimension lumber. Prompt asphalt deliveries.

Chicago—Brick stocks lowering with increasing demand, a condition unusual for this time of the year. Sewer pipe stocks below normal with small demand. Fair quantity of hollow tile on hand. Not much call for reinforcing steel; stocks normal with deliveries taking from one to two days.

New Orleans—No market for asphalt or crushed stone. Orders on yellow pine mills way in excess of production. Stocks of other materials plentiful but demand poor. No creosoted wood paving blocks on hand.

Birmingham—Mill output of steel rails sold for first half of 1923. Cast-iron pipe demand greater than mills can

CONDITIONS OF MATERIALS STOCKS IN IMPORTANT CENTERS

Stocks on hand in approximate figures, example: (Lumber, Minneapolis, 75,000,000 ft.); time required for delivery of carload lots to city job, example: (sewer pipe, Atlanta, 6 @ 8 days); and stocks on hand in general terms, example: (common brick, Philadelphia, shortage.)

	San Francisco	Denver	Minneapolis	Detroit	Chicago	New Orleans	Birmingham	Atlanta	New York	Philadelphia
Sewer pipe....	Plenty, sizes 30-in. and under	Del. 24 hr., local plant	Sufficient	Ample for present needs	Slightly below normal	Stocks fair	Meeting strong demand	Del. take 6 @ 8 days	Mill del. improved	Stocks short
Cement.....	Low	Car conditions improved	Not much on hand	Plenty in storage	Nearby mills	Sufficient	Mills preparing for heavy demand	15 @ 20 cars	Plenty	Depleted
Lime.....	Fair supply	Plenty	No shortage	15 cars	Plenty	Ample	Well supplied	20 @ 30 cars	Enough	30 cars in yards
Common brick	Plenty	4,000,000	Below normal	Local yards well stocked	Stocks lowering	Plentiful	Yards well stocked	Plenty	Dealers piling up stocks in local storage	Shortage
Hollow tile....	Well stocked	Sufficient	Below normal	Moderate reserve	Fair	Enough	Plenty	Del. take 4 @ 6 days	Prompt water deliveries	Stocks low, acct., car situation
Lumber.....	Conditions favorable to lumber movement	Stocks in good shape	75,000,000 ft.	Fair stocks, dimension lumber	Ample, for present demand	Mill demand in excess of production	Unlimited pine reserves	Plenty pine	Del. 7 @ 8 weeks from mill.	Supply limited; deliveries poor
Asphalt.....	Large reserves	Not less than 10 cars	Enough	Deliveries prompt	Plenty	No market	Plenty available	30 @ 40 cars	Large supplies accessible	Heavy reserves
Structural steel	Heavy warehouse stocks	Ample supplies	Enough to meet demands	Sufficient	Bought from mills outside city	Plentiful	High production rate maintained	3 @ 4 cars	Slow mill deliveries	Enough in warehouses

REPORT ON COMMON BRICK FROM 97 YARDS AS OF DEC. 1, 1922

Dist. No.	Including States of	No. of firms reporting	Plants closed down	Burned brick on hand	Unburned brick on hand	Orders on books	Price per thousand at brickyard
1.	N. Y., New England	5	4	4,274,000	2,710,000	2,056,000	$12.00 to $18.00
2.	Pa., N. J., Md., D. C., Del.	11	0	11,792,000	7,390,000	32,165,000	14.00 to 19.00
3.	Va., N. C., S. C., Ga., Fla.	7	1	5,168,000	4,492,000	5,754,000	13.00 to 18.00
4.	Mich., Ohio, W. Va.	7	4	4,551,000	1,982,000	4,824,000	12.00 to 15.00
5.	Ill., Ind., Wis.	25	2	182,930,000	29,476,000	163,448,000	9.50 to 15.50
6.	Ky., Tenn., Miss., Ala., Ark., La.	10	2	5,620,000	3,663,000	8,991,000	9.45 to 16.00
7.	N. & S. Dak., Minn., Neb., Ia., Kan., Mo.	7	3	4,921,000	1,445,000	950,000	10.25 to 15.00
8.	Okla., Tex., N. M.	8	1	5,071,000	2,893,000	1,552,000	7.00 to 12.00
9.	Wash., Ore., Mont., Wyo., Ida., Utah, Colo.	13	2	6,353,000	2,500,000	1,320,000	12.00 to 17.50
10.	Calif., Ariz., Nev.	4	1	8,196,000	8,908,000	8,165,000	14.50 to 15.00
		97	20	238,858,000	65,459,000	229,225,000	

supply. Sewer pipe plentiful and demand strong. Sand shipped in from outside city; supply ample but small.

Atlanta—Plenty of pine lumber and common brick. Hollow tile deliveries take from four to six days; sewer pipe, six to eight days. About thirty or forty cars of asphalt; twenty-five to thirty cars of lime; fifteen to twenty cars of cement and three or four carloads of structural steel, on sidings.

New York—Brick dealers piling up reserve stocks in local storage spaces. Hudson River brick supply hampered by ice. Burned brick on hand in New York and New England district reduced about 33⅓ per cent, in month. No improvement in car supply. No actual shortage of other construction materials.

Philadelphia—Stocks short on sewer pipe and hollow tile, orders held up on account of freight congestion. Small quantities of wood blocks and paving stones on hand with demand active. Shortages of cement and common brick reported. About thirty cars of lime in yards. Lumber deliveries poor with stocks limited; water shipments, however, show improvement over rail.

Freight Loadings Touch New Seasonal High Mark

Freight loadings for the week ending Dec. 23 totaled 834,591 cars, according to the American Railway Association. This represents the heaviest week's loading ever recorded during this season of the year. The record exceeds totals for the corresponding period last year, by 167,986 cars and shows a gain of 186,185 over the same week in 1920.

The following table shows car loadings by weeks since the peak, Oct. 28, 1922, during the last three years:

Week	1922	1921	1920
Dec. 23	834,591	666,605	648,406
Dec. 16	888,082	726,074	802,271
Dec. 9	919,828	741,341	837,953
Dec. 2	845,219	741,849	882,604
Nov. 25	955,495	673,465	803,701
Nov. 18	969,094	790,363	889,138
Nov. 11	953,909	755,777	927,586
Nov. 4	994,827	837,576	915,615
Oct. 28	1,014,480	951,384	981,242

Freight cars awaiting repairs on Dec. 15, totaled 213,837, or 9.4 per cent of the total number on all lines. This represents a reduction of 12,451, compared with the number in need of repairs on Dec. 1, at which time there were 226,288 cars or 9.9 per cent.

Locomotives in bad order on Dec. 15, reached a total of 17,883, which was 27.7 per cent of the total number on all lines. This represents a decrease of 126 compared with the number in need of repair on Dec. 1, at which time there were 18,009 or 27.9 per cent.

Highway Costs in Canada

The average cost per mile for highway construction in the Province of Quebec, Canada, was $10,854 in 1922, according to statistics issued by the Minister of Roads, Dec. 22, 1922. The average cost in New Brunswick and Nova Scotia was $11,800 per mile. The Province of Ontario paid on an average of $23,700 per mile for good roads, during the year. In one instance, thirty-seven miles of highway between Toronto and Ottawa cost $2,400,000. The Minister states that at present Quebec possesses 800 miles of roads and that by the end of 1923, 2,208 miles will have been completed. Cost of maintainance on these roads will average about $300 per mile.

U. S. Court Defines Lawful Trade Associations

Consent Decree in Gypsum Case Lists Lawful Activities and Forbids Specific Violations

In his decree dissolving the Gypsum Industries Association, Judge John C. Knox of the United States District Court at New York has set forth the lawful and unlawful activities of trade associations under the Sherman anti-trust law.

Judge Knox considers it legitimate for trade associations (a) to promote the use of the products of their industries by legitimate and lawful means including research, publicity, and similar activities, (b) to deal with engineering and trade problems pertinent to their industries for the purpose of advancing the use of their products, (c) to promote educational work pertinent to the industry through fellowships in schools and colleges for research, experimental and research work in institutions of learning, scientific bureaus and societies, and to provide for lectures and papers on subjects pertaining to the industry, (d) to maintain a bureau to furnish traffic information upon specific request in each case from published freight tariffs lawfully issued by carriers and to assist the industry in transportation questions before federal and state commissions and other bodies dealing with questions of transportation and with common carriers, (e) to deal with improved methods of plant and mine operation including sanitation, safety, accident prevention, labor, plant and mine development, housing conditions, insurance and methods of accounting, and (f) to maintain a credit bureau for the sole purpose of furnishing credit information.

In Violation of the Law

The following activities are declared to be in violation of the law: (a) Agreement to fix prices to be charged for products, (b) performance by agreement of any act which would result in maintenance of uniform prices, (c) agreement to advance or decrease prices for products, (d) agreement to advise or communicate with one another as to proposed advances or decreases in prices or agreement to circulate among themselves in any way information concerning or relating to proposed advances or decreases or to the prices charged or to be charged, (e) performance by agreement of acts that will result in advising or communicating with one another as to proposed advances or decreases in prices, (f) agreement to restrict or control production or performance through agreement of any act that will restrict or control production such as the withdrawal of salesmen from a certain territory over stipulated periods, (g) agreement as to territory in which any or all producers may sell or otherwise dispose of their products, (h) agreement to effect discrimination whether in prices or otherwise in favor of or against purchasers of products because such purchaser is a mail-order house, purchasing agency, co-operative buying association or so-called dealer or for any other reason, or performance by agreement of any act to effect such discrimination except that each producer may independently of other producers select his own customers and dispose of his own products on such terms as he may choose, (i) agreement to use a published credit list and credit information to blacklist an undesirable purchaser or for the purpose of putting the name of the purchaser on such list with the intent of the manufacturer who submits the name reserving the purchaser's business for himself, (j) agreement to fix terms, differentials, discounts or prices to be followed by dealer, jobber or other middleman upon his resale or the uniform discounts which should be subtracted by each manufacturer as an inducement for cash payment, (k) agreement to follow any price list published by themselves or by any newspaper, trade paper or periodical as a fixed price, (l) agreement to enforce any arbitrary freight rates in excess of those lawfully made, (m) agreement that certain individual manufacturers engage in the manufacture of a certain product of a definite composition and that other manufacturers desist from manufacturing a similar product, and (n) assisting others to do any or all of the matters here enjoined.

The decree further states that nothing contained in it shall be construed to restrain or interfere with the action of any manufacturer with respect to his own business properties or affairs, or from furnishing necessary information to his own customers in connection with bona fide sales of such products, or from doing individually any of the acts described done in good faith to meet competition when this action or the furnishing of this information is not performed in concert as the result of agreement among manufacturers.

Public Roads Bureau Urges Highway Development

Curtailing of Transportation Service More Costly Than Building and Maintaining of Roads

Thomas H. MacDonald, chief of the United States Bureau of Public Roads, in a recent address on the functioning of federal-aid in the development of highway transportation, before the eighth annual convention of the American Association of State Highway Officials, stated the following:

It is about time that we recognize in this country the fact that the development of adequate highways is not a problem for the farmer, nor is it a problem alone for the city man. It is one of the fundamental transportation problems in every locality, and the use of the roads in every locality will reflect the life and activities of the people in the locality. This is demonstrated beyond dispute by the traffic census which we are now carrying forward. Despite any conditions political or otherwise, highway improvement in this country must go forward on an increased scale because it will cost more to do without the transportation service which can be supplied through the building of highways than it will cost to build and maintain them.

Here is an example taken from an industrial section. The recent traffic counts in Connecticut and Massachusetts, taken in October which is an average traffic month, give an average for each of four stations of 1,140 tons of commodities per day of nine hours. Adding one-third as a very conservative estimate for the full day, we have 1,520 gross tons daily commodity movement.

The agricultural tonnage is not large, neither is that of a number of the other activities, but the manufacturing tonnage is the big and important item. The section is devoted largely to manufacturing, and we find reflected the life and activities of the section in the highway commodity movements. Seventy-three per cent of the commodity movement consists of the products of manufacture, the balance being divided between the products of agriculture, mines and forests. From figures which have been published by the Iowa Experiment Station, assuming gasoline to cost 24c. per gal., the cost of the fuel alone for moving this tonnage per mile per day would be $26.44 over an ordinary dirt road, assuming the impossible, that such traffic could be carried over a dirt road. The cost of fuel for moving the same tonnage over a paved road would be $11.70, a difference of $14.74 per day. On the basis of 300 days per year the actual saving in fuel alone moving this tonnage, which comes from the actual weighing of the actual movements, would be $4,022. The paved highway costs approximately $40,000. The average interest at 5 per cent would be $1,000, which, deducted from the actual saving on fuel, would leave a balance which would retire the cost of the road in about eleven years. The maintenance costs are not figured in either case, but a greater maintenance charge could be deducted than the roads are actually costing, and still the balance of the saving would be sufficient to retire the cost within what we believe to be a reasonable period for the service of the road without extensive repairs.

Business Briefs

Bank debits for the week ending Jan. 3 totaled $11,223,963,000, the highest since the Federal Reserve Board started to collect these figures (August, 1918). The week's business was 49 per cent heavier than that of the preceding week. The increase in New York was 65 per cent, in Cleveland 90, Cincinnati 72, St. Louis 63. The chief reason for the great volume is end-of-year settlements.

Call money rate advanced to 4½@5, from 4 per cent. Rise due to deficit in actual reserves of Clearing House banks and to Government withdrawal of $52,000,000, effective Jan. 9.

Time loans, 4½@4¾ per cent for 60@90 days or six months; market dull.

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of January 4; the next, on February 1.

Steel Products:	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Structural shapes, 100 lb.	$3.14	$3.95	$4.40	$3.02½	$3.15	$3.85	$3.25	—$3.70	$3.50
Structural rivets, 100 lb.	3.85	4.60	5.25	3.75	4.00	4.80	4.75	4.25	6.00
Reinforcing bars, ¾ in. up, 100 lb.	3.04	3.85	3 15	2.92½	3.05	3.62½	3.35	—3.70	3.25
Steel pipe, black, 2½ to 6 in. lap, discount	54%	52.50%	45%	59½%	57-5%	41%	39.2@51.8%	40%	—22.50
Cast-iron pipe, 6 in. and over, ton.	+55.20	+48.32	+57.50	+53.67	+56.66	+66.11	+55.50	+55.50	55.00
Concreting Material:									
Cement without bags, bbl.	2.60@2.70	2.54	2.25	2.05	2.29	2.85	2.71	2.90	2.88
Gravel, ¾ in., cu.yd.	2.00	1.75	2.25	2.25	1.75	1.90	2.15	1.00	1.50
Sand, cu.yd.	1.00	1.32	1.87½	2.25	1.00	1.00	1.50	1.00	1.25
Crushed stone, ¾ in., cu.yd.	1.75	2.00	1.65	2.25	2.25	3.50	2.15	3.00	1.90
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	59.00	36.00	+50.00	52.00	+42.75	+50.50	35.00	+25.00	90.00
Lime, finishing, hydrated, ton.	16.80@ 17.10	23.00	22.50	18.00	25.50	24.00	22.00	24.00	21.00
Lime common, lump, per bbl.	2.75@ 3.13½	1.85	2.50	1.40	1.40	2.70	1.75	2.80	11.00
Common brick, delivered, 1,000	23.50	10.00	10.90	11.00	18@19	12.00	15.50	14.00	16.00
Hollow building tile, 4x12x12, per block	Not used	.0859	.115	....	+.0836	.065	....	.11	.115
Hollow partition tile 4x12x12, per block	.1230	.0859	.115	.0674	....	.065	.108	.11	....
Linseed oil, raw, 5 bbl. lots, gal.	—.90	—.95	+1.09	.98	1.01	+1 13	1.04	.86	1.02
Common Labor:									
Common labor, union, hour	.60	.35	.30@.50	.....	.....	.50@.55	.56¼	.50@.60	.....
Common labor, non-union, hour.	.45@.60	.30	.30@.50	.72½	.35@.50	.35@.50	.50	....	.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given: 45-5% means a discount of 45 and 5 per cent. Charge is 15c. per 100 lb. for cutting reinforced steel into 2-ft. lengths or over.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime, in 280-lb. bbl. net, and hydrated lime f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Cement and concrete laborers' rate, 81½c.; pick and shovel men, 60c. per hr.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber delivered on job.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.55 for Kelly Island and $1.45 for Sheboygan. Common labor not organized.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered, in wooden bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers.

Montreal quotes on Douglas fir instead of pine. Sand, stone, gravel and lump lime per ton. Cement, lime and tile are delivered; sand, gravel and stone on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 99.47). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net: 2½-in., $22.50; 6-in., $108.

Changes Since Last Week

Average advance of $2 per ton in cast-iron pipe quotations throughout the country, following rise in pig iron, scrap and coke prices. Steel prices also tending upward. Structural shapes and reinforcing bars firm at $2 per 100 lb., Pittsburgh. No price shading in bars; mills sold up for first quarter delivery. Tendency to shade quotations in structurals, disappeared from market. Mills filled up on orders for shapes; deferred deliveries on new business. Big tonnage buyers purchasing for first half requirements, indicating belief that market will go no lower.

Pine lumber advanced $2 in Dallas; Douglas fir, $2 in Minneapolis and $1.50 per M. ft. b.m. in Seattle. Sharp rise in fir timbers also reported in Denver, due to car shortage and curtailment of operations.

Raw linseed oil in 5-bbl lots, quoted at 90c. as against 93c. per gal., f.o.b., New York. Prices advanced 2c. in Dallas, however, and 5c. per gal. in Denver, during week. Market generally weaker with tendency to shade prices.